Catalogue no. 82-003-X

Health Reports

Volume 19, Number 3

Statistics Canada Statistique Canada

Canada

How to obtain more information

Specific inquiries about this product and related statistics or services should be directed to: Health Information and Research Division, Statistics Canada, Ottawa, Ontario, K1A 0T6 (telephone: 613-951-1765).

For information about this product or the wide range of data available from Statistics Canada, visit our website at **www.statcan.ca** or contact us by e-mail at **infostats@statcan.ca** or by phone from 8:30am to 4:30pm Monday to Friday at:

Toll-free telephone (Canada and the United States):	
Inquiries line	1-800-263-1136
National telecommunications device for the hearing impaired	1-800-363-7629
Fax line	1-877-287-4369
Depository Services Program inquiries line	1-800-635-7943
Depository Services Program fax line	1-800-565-7757
Statistics Canada national contact centre:	1-613-951-8116
Fax line	1-613-951-0581

Accessing and ordering information

This product, catalogue no. 82-003-XIE, is available for free in electronic format. To obtain a single issue, visit our website at **www.statcan.ca** and select **Publications**.

This product, catalogue no. 82-003-XPE, is also available as a standard printed publication at a price of CAN$24.00 per issue and CAN$68.00 for a one-year subscription.

The following additional shipping charges apply for delivery outside Canada:

	Single issue	Annual subscription
United States	CAN$6.00	CAN$24.00
Other countries	CAN$10.00	CAN$40.00

All prices exclude sales taxes.

The printed version of this publication can be ordered by

- Phone (Canada and United States) 1-800-267-6677
- Fax (Canada and United States) 1-877-287-4369
- E-mail infostats@statcan.ca
- Mail Statistics Canada
  Finance Division
  R.H. Coats Bldg., 6th Floor
  100 Tunney's Pasture Driveway
  Ottawa (Ontario) K1A 0T6
- In person from authorized agents and bookstores.

When notifying us of a change in your address, please provide both old and new addresses.

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, the Agency has developed standards of service which its employees observe in serving its clients. To obtain a copy of these service standards, please contact Statistics Canada toll free at 1-800-263-1136. The service standards are also published on **www.statcan.ca** under **About us > Providing services to Canadians**.

HealthReports

Catalogue no. 82-003-XPE • Volume 19 Number 3

A Canadian peer-reviewed journal of population health and health services research

Published by authority of the Minister responsible for Statistics Canada

© Minister of Industry, 2008

All rights reserved. The content of this electronic publication may be reproduced, in whole or in part, and by any means, without further permission from Statistics Canada, subject to the following conditions: that it be done solely for the purposes of private study, research, criticism, review or newspaper summary, and/or for non-commercial purposes; and that Statistics Canada be fully acknowledged as follows: Source (or "Adapted from", if appropriate): Statistics Canada, year of publication, name of product, catalogue number, volume and issue numbers, reference period and page(s). Otherwise, no part of this publication may be reproduced, stored in a retrieval system or transmitted in any form, by any means-electronic, mechanical or photocopy-or for any purposes without prior written permission of Licensing Services, Client Services Division, Statistics Canada, Ottawa, Ontario, Canada K1A 0T6.

September 2008

Catalogue no. 82-003-XPE, Vol. 19, No. 3
ISSN 0840-6529

Catalogue no. 82-003-XIE, Vol. 19, No. 3
ISSN 1209-1367

Frequency: Quarterly

Ottawa

Note of Appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued cooperation and goodwill.

Editor-in-Chief
Christine Wright

Senior Editor
Mary Sue Devereaux

Assistant Editor
Anne Marie Baxter

Production Manager
Robert Pellarin

Creative Services
Rasha Bradic

Administration
Amber Doy-Yat

Associate Editors

David Buckeridge
McGill University

Elizabeth Lin
The Clarke Institute of Psychiatry

Doug Manuel
Institute of Clinical Evaluative Studies

Nazeem Muhajarine
University of Saskatchewan

Georgia Roberts
Statistics Canada

Geoff Rowe
Statistics Canada

Michelle Simard
Statistics Canada

Author information: We seek submissions from researchers based in government or academia. Submissions can come in the form of a traditional research article, a shorter descriptive piece that we call "Health Matters," or a contribution that addresses technical issues related to the analysis of complex health surveys or administrative databases—"Methodological Insights." For detailed author guidelines, please visit the journal's website at: *www.statcan.ca healthreports.*

Electronic version: *Health Reports* is available free in PDF or HTML format. The current issue may be obtained at *www.statcan.ca healthreports*. For previous issues, select "Other issues in the series" from the left sidebar of the *Health Reports* website.

Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for specific reference period
...	not applicable
p	preliminary
r	revised
x	suppressed to meet the confidentiality requirements of the Statistics Act
E	use with caution
F	too unreliable to be published

The paper used in this publication meets the minimum requirements of American National Standard for Information Sciences – Permanence of Paper for Printed Library Materials, ANSI Z39.48 – 1984.

About Health Reports

Health Reports publishes original research on diverse topics related to the health of populations and the delivery of health care. The journal archives, for the research and policy communities and for the general public, discoveries from analyses of national/provincial surveys and administrative databases, as well as results of international comparative health research. *Health Reports* is also a forum for sharing methodological information by those using health surveys or administrative databases. *Health Reports* is produced by the Health Information and Research Division at Statistics Canada. Articles appear monthly in electronic format and quarterly in print, and are indexed in Index Medicus and MEDLINE.

For more information about *Health Reports*, contact the Editor-in-Chief, Health Information and Research Division, Statistics Canada, 24th Floor, R.H. Coats Building, Ottawa, Ontario, Canada K1A 0T6. Telephone: (613) 951-1765; fax: (613) 951-3959; email: Christine.Wright@statcan.ca

Editorial Board

Nancy Ross, Scientic Editor
McGill University and Statistics Canada

Bill Avison
University of Western Ontario

Adam Baxter-Jones
University of Saskatchewan

Lise Dubois
University of Ottawa

James Dunn
University of Toronto and Centre for Research on Inner City Health

Bob Evans
University of British Columbia

David Feeny
Kaiser Permanente

Rick Glazier
Institute for Clinical Evaluative Sciences and University of Toronto

Judy Guernsey
Dalhousie University

Glenn Irwin
Health Canada

Howard Morrison
Public Health Agency of Canada

Cameron Mustard
Institute for Work and Health, University of Toronto

Tom Noseworthy
University of Calgary

Patricia O'Campo
University of Toronto and Centre for Research on Inner City Health

Jennifer O'Loughlin
University of Montreal

Indra Pulcins
Canadian Institute for Health Information

Paul Veugelers
University of Alberta

Michael Wolfson
Statistics Canada

In this issue

Research articles

Depression and risk of heart disease 7

by Heather Gilmour

For people aged 40 or older in 1994/1995, the risk of having developed or died from heart disease by 2006/2007 was significantly higher among women, but not men, who had had an episode of depression.

Parent and child reports of children's activity 19

by Fortune Sithole and Paul J. Veugelers

Relative to children of normal weight, those who were overweight or obese reported more participation in organized and leisure sports and less time watching television than what their parents perceived.

The Canadian census mortality follow-up study, 1991 through 2001 25

by Russell Wilkins, Michael Tjepkema, Cameron Mustard and Robert Choinière

From 1991 to 2001, mortality rates were elevated among people of lower socio-economic status, compared with those of higher socio-economic status, regardless of whether status was determined by education, occupation or income.

Health matters

Motor vehicle accident deaths, 1979 to 2004 45

by Pamela L. Ramage-Morin

Between 1979 and 2004, annual deaths resulting from motor vehicle accidents declined from 25 to 9 per 100,000 population. Nonetheless, motor vehicle accidents are a leading cause of death for young people.

☐ Trends in teen sexual behaviour and condom use... 53

by Michelle Rotermann

In 2005, 43% of teens aged 15 to 19 reported that they had had sexual intercourse at least once, down from 47% in 1996/1997. As well, the proportion of teens reporting that they had become sexually active before age 15 declined.

☐ Diabetes—prevalence and care practices 59

by Claudia Sanmartin and Jason Gilmore

Based on data from six provinces, in 2005, almost three-quarters of adults with diabetes had their hemoglobin AIC checked by a health care professional at least once in the previous year. The majority were also meeting recommendations for eye examinations, but only half had the recommended annual foot examinations.

☐ Organized extracurricular activities of Canadian children and youth 65

by Anne Guèvremont, Leanne Findlay and Dafna Kohen

In 2000/2001, 86% of children and youth aged 6 to 17 had taken part in at least one organized extracurricular activity in the previous year. Participation rose with family income among children aged 6 to 13, but not among 14- to 17-year-olds.

Methodological insights

☐ The feasibility of establishing correction factors to adjust self-reported estimates of obesity..... 71

by Sarah Connor Gorber, Margot Shields, Mark S. Tremblay and Ian McDowell

Regression analyses were used to determine which socio-economic and health characteristics were associated with discrepancies between self-reported and measured values for weight, height and body mass index in the 2005 Canadian Community Health Survey. Correction equations were generated using all predictor variables that were significant at the $p<0.05$ level.

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Depression and risk of heart disease

by Heather Gilmour

Abstract

Objective

A population-based sample of 4,948 men and women aged 40 or older who did not have heart disease in 1994/1995 were followed to 2006/2007 to determine if depression was associated with increased risk of heart disease diagnosis or death.

Data sources

Data from seven cycles of the National Population Health Survey (NPHS), 1994/1995 through 2006/2007, were used for longitudinal analysis. Prevalence estimates of heart disease and depression in the population aged 40 years or older were based on the 2002 Canadian Community Health Survey 1.2: Mental Health and Well-being.

Analytical techniques

The association between depression and heart disease was analyzed with separate proportional hazards models for men and women, adjusting for socio-demographic characteristics and heart disease risk factors.

Main results

Among people aged 40 or older and free of heart disease in 1994/1995, 19% of men and 15% of women had developed or died from heart disease by 2006/2007. The risk of heart disease was significantly higher for women who had depression, but not for men. When heart disease events occurring within two years of baseline were removed, depression was not significantly associated with heart disease risk among women or men.

Keywords

death, major depressive disorder, longitudinal studies, National Population Health Survey (NPHS), proportional hazards models, risk factors

Author

Heather Gilmour (613-951-2114; Heather.Gilmour@statcan.ca) is with the Health Information and Research Division at Statistics Canada, Ottawa, Ontario, K1A 0T6.

Both heart disease and depression are associated with a considerable health burden.[1] Worldwide, coronary heart disease is the second leading cause of disability for men and the third leading cause for women; depression is the fourth leading cause of disability among men and the leading cause among women.[2]

In Canada, according to the 2002 Canadian Community Health Survey (CCHS) 1.2: Mental Health and Well-being, 9.9% of men (an estimated 682,000) and 8.2% of women (606,000) aged 40 or older reported a diagnosis of heart disease. Among this same age group, 2.7% of men (184,000) and 4.1% of women (302,000) met the criteria for having had a major depressive episode in the year preceding the survey.

In addition to common risk factors such as smoking, diabetes, hypertension, alcohol use, physical activity and obesity, psychosocial characteristics have been associated with heart disease.[3] Depression, in particular, has been found to worsen the prognosis of individuals who have suffered acute myocardial infarction (heart attack), and has been studied as a risk factor for the development of heart disease.[4-7] Despite some negative results,[8,9] etiologic studies of populations initially free of heart disease generally support the link between depression and heart disease.[10-23]

Behavioural and physiological factors have been proposed as mechanisms that may explain the relationship between depression and heart disease.[24] Since depression is associated with health behaviours that are, themselves, risk factors for heart disease,[25] it is possible that the link with depression operates via these behaviours. Nonetheless, many studies[10-15] have shown depression to be independently associated with cardiac outcomes when risk factors such as smoking, obesity, diabetes, alcohol use, physical activity, and hypertension are taken into account. The role of physiologic factors that are related to both depression and heart disease, such as shared genetic determinants, heart rate variability and inflammatory processes,[24] may help to explain the association.

This article reports the results of a 12-year prospective study of the relationship between depression and subsequent heart disease diagnosis or death in people initially free of heart

disease, when common heart disease risk factors are controlled.

Data and methods

Data sources

National Population Health Survey

This analysis is based on longitudinal data from the first seven cycles (1994/1995 through 2006/2007) of the National Population Health Survey (NPHS). The household component covers the population living in private households in the 10 provinces in 1994/1995. It excludes people on Indian reserves, in the territories, on Canadian Forces bases, and in some remote areas.

In 1994/1995, 20,095 individuals were selected for the longitudinal panel, 17,276 of whom agreed to participate—a response rate of 86.0%. The response rates for subsequent cycles, based on these 17,276 respondents, were: 92.8% in 1996/1997; 88.2% in 1998/1999; 84.8% in 2000/2001; 80.6% in 2002/2003; 77.4% 2004/2005; and 77.0% in 2006/2007.

This analysis uses the cycle 7 (2006/2007) longitudinal "square" file, which contains records for all members of the original panel, regardless of whether information about them was obtained in every subsequent cycle. More detailed descriptions of the design, sample and interview procedures can be found in published reports.[26,27]

Canadian Community Health Survey: Mental Health and Well-being

Prevalence estimates of heart disease and depression are based on the 2002 Canadian Community Health Survey (CCHS) 1.2: Mental Health and Well-being, which collected information from a sample of 36,984 household residents aged 15 or older living in the 10 provinces. Residents of the three territories, Indian reserves, institutions, and certain remote areas, full-time members of the Canadian Forces, and residents (military and civilian) of military bases were excluded. The response rate was 77%. More detailed descriptions of the design, sample and interview procedures can be found in other reports and on the Statistics Canada Web site.[28,29]

Study sample

The study sample was selected from the 17,276 participants in the NPHS longitudinal panel in 1994/1995 (Chart 1). Respondents whose vital status in 2006/2007 was not known (n=3,889) or who did not have a complete questionnaire response in 1994/1995 (n=294) were excluded, as were those younger than 40 at cycle 1 (1994/1995) (n=6,646). Those who, in 1994/1995, reported a diagnosis of heart disease, had a missing response to the question about heart disease, or reported taking "medicine for the heart" in the previous month (even though they did not report a diagnosis of heart disease) were excluded (n=852). Also excluded were 264 respondents with incomplete depression data in 1994/1995; 220 respondents who had all missing or inconsistent heart disease responses after cycle 1 that could not be confirmed by other survey questions (having heart failure, angina, or ever having had a heart attack in cycles 4 to 7; or taking heart medication in cycles 2 to 7); and 143 respondents for whom cause of death was unknown. Finally, 20 respondents whose first episode of depression in the observation period and first report of heart disease occurred in the same cycle (1994/1995) were removed. The final study sample was 4,948 (2,851 women and 2,097 men).

Definitions

Depression

Using the methodology of Kessler et al.,[30] the NPHS measures *depression* with a subset of questions from the Composite International Diagnostic Interview (CIDI-SF). These questions cover a cluster of symptoms for a depressive disorder, which are listed in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R)*.[31] Respondents were asked about feeling sad, blue or depressed or losing interest in most things for a period of two weeks or more, along with other symptoms including decreased energy, appetite or sleep disturbance, difficulty concentrating, feelings of worthlessness, and/or thoughts about death. Scores were totaled and the results transformed into a probability estimate that the respondent would have met the criteria of a major depressive episode in the past year if he or she had completed the full version of the CIDI. For this article, if the estimate was 0.9 or more, the respondent was considered to have experienced depression in the previous 12 months. The specific questions in the depression module of the NPHS questionnaire can be found at www.statcan.ca/english/sdds/instrument/3225_Q1_V7_E.pdf.

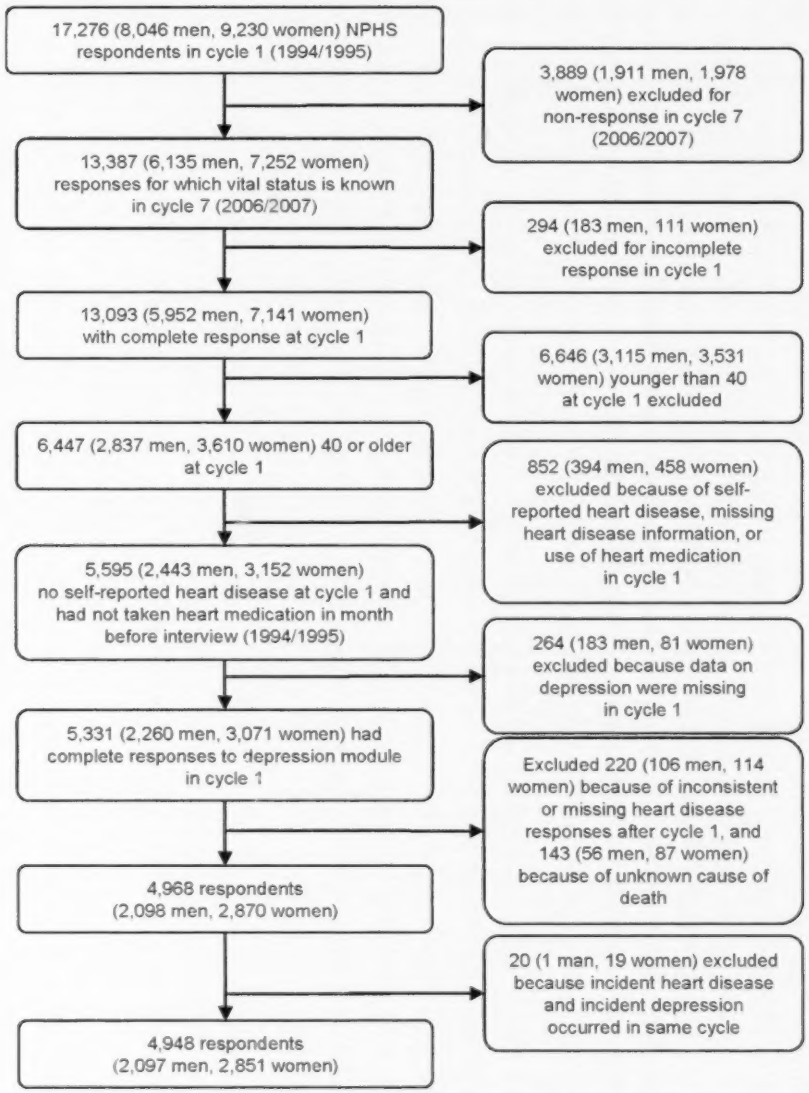
The prevalence estimate of depression from the CCHS 1.2 is based on the World Mental Health version of the Composite International Diagnostic Interview (WMH-CIDI). The WMH-CIDI was designed to be administered by lay interviewers and is generally based on diagnostic criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (DSM-IV®-TR).[32] The CCHS questionnaire is available at http://www.statcan.ca/english/sdds/instrument/5015_Q1_V1_E.pdf. The algorithm used to measure the 12-month prevalence of depression is available in the Annex of the 2004 *Health Reports* supplement.[33]

Depression estimates from CCHS 1.2 exclude respondents who had also experienced an episode of mania in their lifetime, but NPHS estimates do not.

Heart disease

The prevalence of chronic conditions was based on self-reports of diagnosed illness. Respondents were asked about any "long-term health conditions that have lasted or are expected to last six months or more and that have been diagnosed by a health professional." The NPHS used a checklist of

Chart 1
Study sample


17,276 (8,046 men, 9,230 women) NPHS respondents in cycle 1 (1994/1995)
3,889 (1,911 men, 1,978 women) excluded for non-response in cycle 7 (2006/2007)
13,387 (6,135 men, 7,252 women) responses for which vital status is known in cycle 7 (2006/2007)
294 (183 men, 111 women) excluded for incomplete response in cycle 1
13,093 (5,952 men, 7,141 women) with complete response at cycle 1
6,646 (3,115 men, 3,531 women) younger than 40 at cycle 1 excluded
6,447 (2,837 men, 3,610 women) 40 or older at cycle 1
852 (394 men, 458 women) excluded because of self-reported heart disease, missing heart disease information, or use of heart medication in cycle 1
5,595 (2,443 men, 3,152 women) no self-reported heart disease at cycle 1 and had not taken heart medication in month before interview (1994/1995)
264 (183 men, 81 women) excluded because data on depression were missing in cycle 1
5,331 (2,260 men, 3,071 women) had complete responses to depression module in cycle 1
Excluded 220 (106 men, 114 women) because of inconsistent or missing heart disease responses after cycle 1, and 143 (56 men, 87 women) because of unknown cause of death
4,968 respondents (2,098 men, 2,870 women)
20 (1 man, 19 women) excluded because incident heart disease and incident depression occurred in same cycle
4,948 respondents (2,097 men, 2,851 women)

Sources: 1994/1995 to 2006/2007 National Population Health Survey, longitudinal square file.

conditions, one of which was *heart disease*.

Use of *heart medication* was determined by asking respondents if, in the past month, they had taken "medicine for the heart."

Heart disease death was based on ICD-10 codes for ischaemic heart disease (I20-I25) or heart failure (I50.0-I50.9).

Covariates

Age in 1994/1995 was used as a continuous variable and contained values of 40 years or more.

Three *marital status* categories were specified: partner (married, common-law or living with partner); separated, divorced or widowed; and never married.

Household income was based on total self-reported household income from all sources in the previous 12 months. The ratio between total household income and the low-income cut-off corresponding to the number of people in the household and community size was calculated. The ratios were then adjusted by dividing them by the highest ratio for all NPHS respondents. The adjusted ratios were grouped into deciles, which were collapsed into five household income categories: low (deciles 1 and 2), low to middle (deciles 3 and 4), middle (deciles 5 and 6), high to middle (deciles 7 and 8) and high (deciles 9 and 10). More information on the income variable can be found in the NPHS derived variable documentation at www.statcan.ca/english/sdds/document/3225_D10_T9_V3_E.pdf.

High blood pressure was measured by self-reported diagnosis of the condition or indication that the respondent had taken "medicine for blood pressure" in the past month.

Diabetes was measured by self-reported diagnosis of the condition.

Body mass index (BMI) is calculated by dividing self-reported weight in kilograms by the square of self-reported height in metres. The BMI groups used in this article were: underweight/acceptable (BMI less than 25kg/m^2), overweight (25.0 kg/m^2 to 29.9 kg/m^2) and obese (30 kg/m^2 or more).

Smoking status was grouped into six categories based on current and former smoking habits: current daily/occasional smoker; former occasional smoker (smoked in the past, but not daily); quit daily smoking 0 to 4 years ago; quit daily smoking 5 to 9 years ago; quit daily smoking 10 or more years ago; and never smoker.

Leisure-time physical activity was based on total accumulated energy expenditure (EE) during leisure time. EE was calculated from the reported frequency and duration of all of a respondent's leisure-time physical activities in the three months before the interview and the energy cost of

the activity (kilocalories expended per kilogram of body weight per hour of activity). To calculate an average daily EE for an activity, the estimate was divided by 365. This calculation was repeated for each leisure-time activity reported, and the resulting estimates were summed to provide an aggregate average daily EE. Respondents whose leisure-time EE was 3.0 or more kcal/kg/day were considered active; 1.5 to 2.9 kcal/kg/day, moderately active; and less than 1.5 kcal/kg/day, inactive.

Identification of respondents who participate in *non-leisure physical activity* was based on usual daily activities and work habits over the previous three months. Those who reported that they "stand or walk quite a lot," "lift or carry light loads," or "do heavy work or carry very heavy loads" were considered to participate in non-leisure physical activity, compared with those who reported that they "usually sit and don't walk around very much."

Alcohol use was determined by asking:

- "During the past 12 months, have you had a drink of beer, wine, liquor or any other alcoholic beverage?"
- "Have you ever had a drink?"
- Thinking back over the past week, did you have a drink of beer, wine, liquor or any other alcoholic beverage?"

For each day in the past week the respondent was asked, "How many drinks did you have?" Five categories of alcohol use were established: never in lifetime; former drinker; light drinker (1 drink or less in past week); moderate drinker for men (2 to 14 drinks in the past week); and heavy drinker for men (15 or more drinks in the past week). Because few women were in the heavy drinker category, moderate drinking (2 to 9 drinks in past week) and heavy drinking (10 or more drinks in past week) were combined.

Use of *hormone replacement therapy* was determined during the 1994/1995 NPHS interview by asking women aged 30 or older if they had taken "hormones for menopause or aging symptoms" in the past month.

Statistical analyses

To identify variables that were associated with an increased or decreased risk of being diagnosed with or of dying from heart disease, Cox proportional hazards modeling was used. This technique allows for the study of relationships between individual characteristics and an outcome when that outcome can take place over a period of time. The method accounts for the possibility that respondents do not develop or die from heart disease during the study period, and it minimizes the bias associated with attrition.

Because heart disease is relatively rare at younger ages, the analysis was restricted to respondents aged 40 or older at cycle 1 (1994/1995). Since the prevalance of and characteristics associated with heart disease and depression differ between men and women,[34] the analysis was stratified by sex.

If a respondent reported a diagnosis of heart disease or died of ischaemic heart disease or heart failure after 1994/1995, this was considered an event. Given that the development of heart disease is a continuous process that was measured only at discrete intervals (the NPHS interviews every two years), many transitions to a heart disease event were recorded at the same time, after 2, 4, 6, 8, 10 or 12 years. Thus, the complementary log-log model was used.[35]

If self-reported heart disease information was missing for one or more survey cycles but values for subsequent cycles were available, the cases were retained. This creates intervals of varying lengths between observations. To control for the fact that the longer the interval, the more likely a respondent was to develop heart disease, values for interval length and interval length square were entered as independent variables in the model.

An imputed value of "No" to the heart disease question was used if a missing response was bounded by "No's" in the previous and subsequent cycles. Of the 4,948 respondents, 493 (10.0%) contain imputed "No" response(s) to the heart disease question in one or more cycles.

The 4,948 respondents were followed until 2006/2007. During the follow-up period, there were 429 heart disease diagnoses or deaths among men, and 486 among women. Two models were applied. The first adjusted for depression, age and the varying lengths of time between observations. The second adjusted for these variables and also for socio-demographic variables, chronic conditions and health behaviours. Independent variables were measured as of 1994/1995, except for depression, which was measured at baseline and in subsequent cycles. A respondent was considered to have experienced depression from their first occurrence of depression during the study period, such that it became a "characteristic" of the respondent from that point onward. If data were missing for depression in a given cycle and the respondent had not experienced depression in a previous cycle, the respondent was considered not to have depression for that cycle.

In an effort to study the population without heart disease, respondents who reported a diagnosis of heart disease or use of heart medication at baseline were excluded. But since clinical examinations were not part of the survey, it is possible that some respondents who remained in the sample had undetected or sub-clinical heart disease. To minimize the possibility that sub-clinical or undetected disease at baseline biased the relationship between depression and heart disease, the analysis was repeated after excluding heart disease events that occurred in the first cycle of follow-up.

All the analyses were weighted using the longitudinal weights constructed to represent the total population in 1994. The bootstrap method was used to

account for the complex survey design in the calculation of confidence intervals and in the assessment of statistical significance.[36-38] The significance level was set at $p < 0.05$.

Results

Estimates from the study population indicate that 16.8% of women and 10.9% of men ($p<0.001$) experienced depression in at least one of the seven survey cycles. Both men and women who experienced depression were, on average, approximately 5 years younger at baseline, were more likely to be current smokers, and were more likely to be taking antidepressants, compared with those who did not experience depression (Appendix Table A). Women who experienced depression were less likely to be never drinkers and to have high blood pressure, and were more likely to be using hormone replacement therapy and to be in the high income group.

Among people who did not report heart disease or the use of heart medication in 1994/1995, 19% of men and 15% of women either reported a new diagnosis of heart disease or died from ischaemic heart disease or heart failure during the next 12 years (Table 1). Incident heart disease diagnoses (rather than death) represented 81.6% of the heart disease events for men and 86.8% of the events for women.

Women with depression were more likely to have a heart disease event, compared with those without depression (HR=1.8, 95% CI=1.3, 2.7); men with depression did not have a significantly higher risk of having a heart disease event (HR=1.4, 95% CI=0.8, 2.4) (Tables 2 and 3). When the model was adjusted for other heart disease risk factors, the risk was attenuated slightly for women with depression (HR=1.7, 95% CI=1.1, 2.5), but remained significant. For men with depression, the risk of heart disease was not significantly higher in the covariate-adjusted model (HR=1.2, 95% CI=0.7, 2.2).

When respondents with incident heart disease in the first two years after baseline (one survey cycle) were removed from the model (94 men, 90 women), depression was not significantly associated with heart disease for either men (HR= 1.6, 95% C.I.=0.8, 3.0) or women (HR=1.5, 95% C.I.=0.9, 2.4). The excluded respondents represented 21.9% of incident heart disease events for men and 18.5% for women.

Discussion

This is the first nationally representative study of the association between depression and incident heart disease in the Canadian population. Depression was found to be associated with incident heart disease among women, even when adjusting for other risk factors. The association between depression and heart disease did not reach statistical significance for men. Although most previous studies did not stratify the analysis by sex, evidence from adequately adjusted studies indicates that the association between depression and heart disease exists in both men and women.[12,14,39] Since heart disease develops over a long period, the 12-year interval may not have been long enough for the full effect of associations between depression and heart disease to emerge among men.

When heart disease events that occurred in the first two years of follow-up (one survey cycle) were eliminated from the analysis, the relationship between depression and heart disease, although positive and consistent with the other models, did not reach statistical significance for either sex. Other studies that have used this technique[20,21,39] found that the association between depression and heart disease remained after eliminating the first two years of follow-up in their samples of men. The smaller sample in the present study may have reduced the statistical power of the models. However, it is possible that sub-clinical or undetected disease at baseline affected the results of analysis in the full sample.

Of the studies that did not find significant associations between depression and heart disease, the Framingham study[8] used a different depression instrument, a shorter follow-up (6 years), and included younger respondents (30 or older), all of which might contribute to differences from the present analysis. The Leiden-85 study[9] was confined to people aged 85 or older, and as noted in a recent review,[10] the results may be influenced by the inclusion of exceptionally healthy individuals who lived to an advanced age without heart disease, as well as to low statistical power due to a smaller sample.

Some factors that were treated as confounders in the present analysis may actually be in the causal pathway between depression and heart disease (for example, smoking, alcohol use,

Table 1
New diagnosis of or death from heart disease between 1994/1995 and 2006/2007, by sex, household population aged 40 or older with no diagnosis of heart disease or use of heart medication in 1994/1995, Canada excluding territories

	Women			Men		
	Sample size	Estimated population '000	%	Sample size	Estimated population '000	%
Total	2,851	3,792	100	2,097	3,195	100
No diagnosis of or death from heart disease	2,365	3,227	85.1	1,668	2,603	81.4
Diagnosis of or death from heart disease	486	566	14.9	429	594	18.6

Note: Deaths attributed to heart disease are based on records for which cause of death was available.
Sources: 1994/1995 to 2006/2007 National Population Health Survey, longitudinal square file.

Table 2
Adjusted proportional hazards ratios relating selected characteristics to diagnosis or death from heart disease between 1996/1997 and 2006/2007, female household population aged 40 or older and free of heart disease in 1994/1995, Canada excluding territories

	Model 1 (adjusted for depression and age)		Model 2 (fully adjusted)		Model 3 (fully adjusted, excluding heart disease diagnoses and deaths during cycle after baseline)	
Characteristics in 1994/1995	Proportional hazards ratio	95% confidence interval	Proportional hazards ratio	95% confidence interval	Proportional hazards ratio	95% confidence interval
Depression in past 12 months†	1.8*	1.3 to 2.7	1.7*	1.1 to 2.5	1.5	0.9 to 2.4
Age (continuous)	1.07*	1.06 to 1.09	1.07*	1.05 to 1.08	1.06*	1.04 to 1.09
Household income						
High‡	...	...	1.0	...	1.0	...
Middle to high	...	...	1.3	0.8 to 2.2	0.8	0.4 to 1.4
Middle	...	...	1.2	0.7 to 1.9	1.0	0.6 to 1.8
Low to middle	...	...	1.1	0.6 to 1.9	1.0	0.5 to 1.9
Low	...	...	1.3	0.8 to 2.2	1.1	0.6 to 2.0
Marital status						
Partner‡	...	...	1.0	...	1.0	...
Widowed/Separated/Divorced	...	...	1.0	0.8 to 1.3	1.1	0.8 to 1.6
Never married	...	...	0.6	0.4 to 1.2	0.7	0.3 to 1.4
High blood pressure	...	...	1.9*	1.4 to 2.5	2.0*	1.4 to 2.9
Diabetes	...	...	1.9*	1.2 to 2.9	1.9*	1.2 to 3.1
Body mass index						
Underweight/Acceptable‡	...	...	1.0	...	1.0	...
Overweight	...	...	1.1	0.8 to 1.4	1.2	0.9 to 1.8
Obese	...	...	1.0	0.7 to 1.5	1.3	0.8 to 2.0
Smoking status						
Current daily or occasional smoker	...	...	1.8*	1.2 to 2.6	2.2*	1.3 to 3.5
Former occasional smoker	...	...	0.9	0.6 to 1.6	1.0	0.5 to 2.0
Quit daily smoking less than 4 years	...	...	2.4*	1.4 to 4.4	2.7*	1.3 to 5.4
Quit daily smoking 5 to 9 years	...	...	1.6	0.8 to 2.9	2.3*	1.1 to 4.8
Quit daily smoking 10 or more years	...	...	1.2	0.9 to 1.7	1.3	0.9 to 2.0
Never smoker‡	...	...	1.0	...	1.0	...
Leisure-time physical activity						
Inactive‡	...	...	1.0	...	1.0	...
Moderately active	...	...	0.9	0.6 to 1.2	0.9	0.6 to 1.5
Active	...	...	0.9	0.6 to 1.4	0.8	0.5 to 1.3
Non-leisure physical activity	...	...	0.8	0.6 to 1.1	0.7*	0.5 to 1.0
Alcohol use						
Never drank‡	...	...	1.0	...	1.0	...
Former drinker	...	...	0.8	0.5 to 1.2	0.8	0.5 to 1.2
Light drinker	...	...	0.7	0.5 to 1.0	0.7	0.4 to 1.1
Moderate/Heavy drinker	...	...	0.5*	0.3 to 0.8	0.4*	0.2 to 0.8
Hormone replacement therapy in past month	...	...	1.1	0.7 to 1.6	0.9	0.6 to 1.5

† time-varying co-variate
‡ reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable

Note: Because of rounding, some hazards ratios with 1.0 as lower/upper confidence limit are statistically significant. To maximize sample size, "missing" categories were included for several variables, but hazards ratios are not shown. A variable was included to control for varying length of time between observations, but hazards ratios are not shown.
Source: 1994/1995 to 2006/2007 National Population Health Survey, longitudinal square file.

Table 3
Adjusted proportional hazards ratios relating selected characteristics to diagnosis or death from heart disease between 1996/1997 and 2006/2007, male household population aged 40 or older and free of heart disease in 1994/1995, Canada excluding territories

	Model 1 (adjusted for depression and age)		Model 2 (fully adjusted)		Model 3 (fully adjusted, excluding heart disease diagnoses and deaths during cycle after baseline)	
Characteristics in 1994/1995	Proportional hazards ratio	95% confidence interval	Proportional hazards ratio	95% confidence interval	Proportional hazards ratio	95% confidence interval
Depression in past 12 months†	1.4	0.8 to 2.4	1.2	0.7 to 2.2	1.6	0.8 to 3.0
Age (continuous)	1.07*	1.06 to 1.08	1.07*	1.0 to 1.1	1.07*	1.05 to 1.08
Household income						
High‡	...	...	1.0	...	1.0	...
Middle to high	...	...	0.9	0.6 to 1.3	1.0	0.6 to 1.7
Middle	...	...	1.0	0.7 to 1.5	1.1	0.7 to 1.7
Low to middle	...	...	1.0	0.6 to 1.5	1.0	0.6 to 1.7
Low	...	...	1.0	0.7 to 1.6	0.9	0.5 to 1.7
Marital status						
Partner‡	...	...	1.0	...	1.0	...
Widowed/Separated/Divorced	...	...	0.7	0.5 to 1.0	0.8	0.6 to 1.3
Never married	...	...	0.9	0.6 to 1.4	0.9	0.5 to 1.6
High blood pressure	...	...	1.5*	1.1 to 2.0	1.5*	1.1 to 2.3
Diabetes	...	...	1.9*	1.2 to 3.1	1.8*	1.0 to 3.3
Body mass index						
Underweight/Acceptable‡	...	...	1.0	...	1.0	...
Overweight	...	...	1.3	1.0 to 1.9	1.1	0.8 to 1.6
Obese	...	...	1.9*	1.2 to 3.0	1.8*	1.1 to 2.8
Smoking status						
Current daily or occasional smoker	...	...	1.3	0.8 to 1.9	1.0	0.6 to 1.6
Former occasional smoker	...	...	1.1	0.6 to 1.9	0.8	0.4 to 1.8
Quit daily smoking less than 4 years	...	...	1.6	0.9 to 3.1	1.1	0.5 to 2.5
Quit daily smoking 5 to 9 years	...	...	0.8	0.4 to 1.6	0.6	0.2 to 1.6
Quit daily smoking 10 or more years	...	...	1.0	0.7 to 1.4	0.8	0.5 to 1.3
Never smoker‡	...	...	1.0	...	1.0	...
Leisure-time physical activity						
Inactive‡	...	...	1.0	...	1.0	...
Moderately active	...	...	0.6*	0.4 to 0.9	0.7	0.5 to 1.1
Active	...	...	1.2	0.9 to 1.7	1.2	0.8 to 1.8
Non-leisure physical activity	...	...	0.7*	0.5 to 0.9	0.8	0.5 to 1.2
Alcohol use						
Never drank‡	...	...	1.0	...	1.0	...
Former drinker	...	...	1.4	0.7 to 2.8	1.6	0.7 to 3.6
Light drinker	...	...	1.3	0.6 to 2.5	1.2	0.6 to 2.7
Moderate/Heavy drinker	...	...	1.1	0.5 to 2.1	1.1	0.5 to 2.3
Heavy drinker	...	...	0.7	0.3 to 1.6	0.8	0.3 to 2.3

† time-varying co-variate
‡ reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable

Note: Because of rounding, some hazards ratios with 1.0 as lower/upper confidence limit are statistically significant. To maximize sample size, "missing" categories were included for several variables, but hazards ratios are not shown. A variable was included to control for varying length of time between observations, but hazards ratios are not shown.
Source: 1994/1995 to 2006/2007 National Population Health Survey, longitudinal square file.

Why is this study important?

- From a public health and disease prevention perspective, it is important to understand the role of depression as a potential risk factor for heart disease.

What else is known on this topic?

- The majority of population-based studies have found that depression is associated with increased risk of incident heart disease in an initially healthy population. However, some results have been inconsistent.

What does this study add?

- For the first time, national population-based data are used to investigate the association between depression and incident heart disease in Canada. When other risk factors were controlled, depression was significantly associated with increased risk of heart disease among women, but not among men.

obesity, physical activity). The fact that the hazards ratios for depression were somewhat attenuated when controlling for these other risk factors suggests that the impact of depression on heart disease may operate, at least in part, via these health behaviours.

Most previous studies measured depression only at baseline, which may have underestimated associations between depression and heart disease. A strength of the present study is that the measure of depression was repeated at each survey cycle.

Limitations

NPHS respondents were asked if they had "heart disease," but no information was collected on the specific type. However, self-reports of heart disease diagnoses likely reflect common conditions such as coronary heart disease and myocardial disease. Although it would have been more precise to limit the outcome to confirmed ischemic heart disease fatalities and heart failure fatalities, the low number in the sample (102 men, 86 women) precluded this option. A small portion of sample respondents whose incident heart disease event was based on a self-reported diagnosis died of ischemic heart disease or heart failure during the follow-up period (6.6% of men and 5.2% of women).

The degree to which the self-reported diagnoses of chronic conditions, including heart disease, are inaccurate because of reporting error is unknown.

The CIDI-SF used to assess major depression on the NPHS is not a validated instrument, although the criteria it uses are consistent with the DSM-III-R. Moreover, the CIDI-SF does not discount symptoms due to physical illness, alcohol or drug use, or bereavement. Consequently, the symptoms of some respondents classified as having depression may actually have been due to physical illness, milder forms of depressive disorder, or bereavement.[40]

The NPHS collects data every two years, but the depression questions refer to the 12 months before the interview. Thus, there is a one-year period between survey cycles for which depression information is not available, so the prevalence of depression among the study population may be underestimated.

A dose-response relationship between depressive symptoms and incident heart disease has been found in other studies.[10,23] However, the CIDI-SF depression measure is designed for use as a dichotomous rather than a continuous variable. Thus, it was not possible to investigate whether the risk of heart disease increased with the severity of depression.

Respondents with missing values for depression and who had not met the criteria for depression in previous NPHS cycles were considered not to have depression for that cycle. If cycle non-response to the depression questions was higher among individuals experiencing depression, the prevalence of depression in the sample would be underestimated.

It would be interesting to know the proportion of people who had repeated episodes of depression during the study period. However, respondents' length of exposure to risk of depression varied because nearly one-fifth of them (19.4%) died over the 12-year period, and values for depression were missing in some cycles. Nonetheless, this study addresses whether *any* episode of depression during the period was associated with incident heart disease, so the number of occurrences of depression is not directly relevant to the results of this analysis.

Not all factors known to be associated with incident heart disease could be examined. For example, the NPHS does not collect data on diet, aspirin use, or biological measures such as blood lipids. Family history of heart disease was collected in cycle 3 (1998/1999), but because this information was not available for respondents who had died by that time, it was not used. Similarly, lifetime history of depression was not collected until cycle 6 (2004/2005), and as a result, the possible influence of depression before the baseline year was not assessed.

The lack of association between heart disease and some common risk factors, such as smoking and household income in men and leisure-time physical activity and BMI in women, is unexpected. This may reflect limitations in how these covariates were measured. For example, smoking status does not indicate smoking intensity, which may have contributed to the weak association between smoking and heart disease in men in the full model. Also, obesity

was based on self-reported weight and height, which tend to yield lower estimates than those based on measured data.[41] The result for this analysis could be an underestimation of the association between obesity and heart disease, which, in turn, might influence the observed association between depression and heart disease. However, household income and smoking were significantly associated with heart disease in restricted models that controlled for them individually along with depression and a variable to control for the varying length of time between observations; leisure-time physical activity and BMI were not (data not shown).

The exclusion of 3,899 records for non-response in cycle 7 (some of which may be due to the death of the respondent) and 143 deaths for which cause of death was not available limited the statistical power of the analysis. For these reasons, the analysis may underestimate associations that could emerge when more complete data for these records become available.

Conclusion

Although this and other studies indicate an association between depression and heart disease, a causal link between the two disorders has not been confirmed. Future research can help illuminate the mechanisms underlying this association, whether they be health behaviours, physiologic factors, or other unmeasured or yet unidentified variables. The results of this study highlight the importance of monitoring people with depression for the development of heart disease. ■

Acknowledgements

The author thanks Marc Joncas for his advice on statistical methods.

References

1. Lopez AD, Mathers CD, Ezzati M, et al. Global and regional burden of disease and risk factors, 1001: systematic analysis of population health data. *Lancet* 2006; 367: 1747-57.
2. Mackay J, Mensah GA. *The Atlas of Heart Disease and Stroke*. Geneva: World Health Organization, 2004.
3. Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet* 2004; 364: 937-52.
4. Kubzansky LD. Sick at heart: the pathophysiology of negative emotions. *Cleveland Clinic Journal of Medicine* 2007; 74(supplement 1): S67-S72
5. Everson-Rose SA, Lewis TT. Psychosocial factors and cardiovascular diseases. *Annual Review of Public Health* 2005; 6: 469-500.
6. Kuper H, Marmot M., Hemingway H. Systematic review of prospective cohort studies of psychosocial factors in the etiology and prognosis of coronary heart disease. *Seminars in Vascular Medicine* 2002; 2(3): 267-314
7. Rozanski A, Blumenthal JA, Kaplan J. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation* 1999; 99: 2192-217.
8. Wulsin LR, Evans JC, Ramachandran SV, et al. Depressive symptoms, coronary heart disease, and overall mortality in the Framingham Heart Study. *Psychosomatic Medicine* 2005; 67: 697-702.
9. Vinker DJ, Stek ML, Gussekloo J et al. Does depression in old age increase only cardiovascular mortality? The Leiden 85-plus study. *International Journal of Geriatric Psychiatry* 2004; 19: 852-7.
10. Frasure-Smith N, Lespérance F. Recent evidence linking coronary heart disease and depression. *Canadian Journal of Psychiatry* 2006; 51(12): 730-7.
11. Nicholson A, Kuper H, Hemingway H. Depression as an aetiologic and prognostic factor in coronary heart disease: a meta-analysis of 6,362 events among 146,538 participants in 54 observational studies. *European Heart Journal* 2006; 27(23): 2763-74.
12. Frasure-Smith N, Lespérance F. Reflections on depression as a cardiac risk factor. *Psychosomatic Medicine* 2005; 67(supplement 1): S19-S25.
13. Lett HS, Blumentahl JA, Babyak MA, et al. Depression as a risk factor for coronary artery disease: evidence, mechanisms, and treatment. *Psychosomatic Medicine* 2004; 66: 305-15.
14. Wulsin LR, Singal BM. Do depressive symptoms increase the risk for the onset of coronary disease? A systematic quantitative review. *Psychosomatic Medicine* 2003; 65: 201-10.
15. Rugulies R. Depression as a predictor for coronary heart disease: a review and meta-analysis. *American Journal of Preventive Medicine* 2002; 23(1): 51-61.
16. Barefoot JC, Schroll M. Symptoms of depression, acute myocardial infarction, and total motrality in a community sample. *Circulation* 1996; 93: 1976-80.
17. Penninx BWJH, Beckman ATF, Honig A, et al. Depression and cardiac mortality. *Archives of General Psychiatry* 2001; 58: 221-7.
18. Marzari C, Maggi S, Manzato E, et al. Depressive symptoms and development of coronary heart disease: the Italian longitudinal study on aging. *Journals of Gerontology series A, Biological Sciences and Medical Sciences* 2005; 60(1): 85-92.
19. Bremmer MA, Hoogendijk WJG, Deeg DJH, et al. Depression in older age is a risk factor for first ischemic cardiac events. *American Journal of Geriatric Psychiatry* 2006; 14(6): 523-30.

20. Anda R, Williamson D, Jones D, et al. Depressed affect, hopelessness, and the risk of ischemic heart disease in a cohort of U.S. adults. *Epidemiology* 1993; 4: 285-94.

21. Ford DE, Mead LA, Chang PP, et al. Depression is a risk factor for coronary artery disease in men : the Precursors Study. *Archives of Internal Medicine* 1998; 158: 1422-6.

22. Ariyo AA, Haan M, Tangen CM, et al. Depressive symptoms and risks of coronary heart disease and mortality in elderly Americans. *Circulation* 2000; 102: 1773-9.

23. Rowan PJ, Haas D, Campbell JA, et al. Depressive symptoms have an independent, gradient risk for coronary heart disease incidence in a random, population-based sample. *Annals of Epidemiology* 2005; 15: 316-20.

24. Skala JA, Freedland KE, Carney RM. Coronary heart disease and depression: a review of recent mechanistic research. *Canadian Journal of Psychiatry* 2006; 51(12): 738-45.

25. van Gool CH, Kempen GI, Penninx BW, et al. Relationship between changes in depressive symptoms and unhealthy lifestyles in late middle aged and older persons: results from the Longitudinal Aging Study Amsterdam. *Age and Ageing* 2003; 32(1): 81-7.

26. Tambay J-L, Catlin G. Sample design of the National Population Health Survey. *Health Reports* (Statistics Canada, Catalogue 82-003) 1995; 7(1): 29-38.

27. Swain L, Catlin G, Beaudet MP. The National Population Health Survey – its longitudinal nature. *Health Reports* (Statistics Canada, Catalogue 82-003) 1999; 10(4): 69-82.

28. Béland Y, Dufour J, Gravel R. Sample design of the Canadian Mental Health Survey. *Proceedings of the Survey Methods Section*. Vancouver: Statistical Society of Canada, 2001: 93-8.

29. Statistics Canada. *Canadian Community Health Survey (CCHS): Mental Health and Well-being - Cycle 1.2*. Available at: http://www.statcan.ca/english/concepts/health/cycle1_2/index.htm. Accessed December 13, 2007.

30. Kessler RC, McGonagle KA, Zhoa S, et al. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States. Results from the National Comorbidity Survey. *Archives of General Psychiatry* 1994; 51: 8-19.

31. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Text Revision*. Washington DC: American Psychiatric Association, 1980.

32. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*. Washington, DC: American Psychiatric Association, 2000.

33. Statistics Canada. Annex. *Health Reports* (Catalogue 82-003) 2004; 15(Suppl.): 65-79.

34. Naqvi TZ, Naqvi SSA, Merz CN. Gender differences in the link between depression and cardiovascular disease. *Psychosomatic Medicine* 2005; 67(supplement 1): S15-S18.

35. Prentice RL, Gloeckler LA. Regression analysis of grouped survival data with application to breast cancer data. *Biometrics* 1978; 34: 57-67.

36. Rao JNK, Wu CFJ, Yue K. Some recent work on resampling methods for complex surveys. *Survey Methodology* (Statistics Canada, Catalogue 12-001) 1992; 18(2): 209-17.

37. Rust KF, Rao JNK. Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research* 1996; 5: 281-310.

38. Yeo D, Mantel H, Liu TP. Bootstrap variance estimation for the National Population Health Survey. *Proceedings of the Annual Meeting of the American Statistical Association: Survey Research Methods Section, August 1999*. Baltimore, Maryland: American Statistical Association, 1999.

39. Ferketich AK, Schwartzbaum JA, Frid D, Moeschberger ML. Depression as an antecedent to heart disease among women and men in the NHANES I study. *Archives of Internal Medicine* 2000; 160: 1261-8.

40. Patten SB, Brandon-Christie J, Devji J, Sedmak B. Performance of the Composite International Diagnostic Interview Short Form for Major Depression in a Community Sample. *Chronic Diseases in Canada* 2000; 21(2): 68-72.

41. Connor Gorber S, Tremblay M, Moher D, et al. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obesity Reviews* 2007; 8(4): 307-26.

Appendix

Table A
Baseline (1994/1995) characteristics of study sample, by depression, household respondents aged 40 or older free of heart disease in 1994/1995, Canada excluding territories

	Had depression in any survey cycle			
	Women		Men	
Characteristics in 1994/1995	No	Yes	No	Yes
Mean age (years)	57.5	51.2**	55.2	50.1**
	%		%	
Income				
High†	19.7	25.6*	27.9	20.7E
Middle to high	18.2	17.7	18.8	24.9E
Middle	18.2	15.4	19.2	14.5E
Low to middle	20.3	17.4	15.7	16.5E
Low	16.8	17.4	12.3	13.8E
Marital status				
Partner†	67.8	69.4	82.4	80.1
Widowed/Separated/Divorced	26.6	24.9	11.4	13.3E
Never married	5.6	5.7E	6.2	6.6E
High blood pressure	19.4	14.8*	13.1	17.1E
Diabetes	3.8	5.2E	4.8	6.4E
Body mass index				
Underweight/Acceptable†	48.1	48.7	35.1	37.9
Overweight	35.1	35.2	49.3	50.7
Obese	15.1	15.1	15.4	11.4E
Smoking status				
Current daily or occasional smoker	19.7	31.8**	29.1	42.1*
Former occasional smoker	6.3	6.2E	7.1	F
Quit daily smoking less than 4 years ago	4.1	2.9E	4.2	4.7E
Quit daily smoking 5 to 9 years ago	4.1	4.9E	5.9	8.4E
Quit daily smoking 10 or more years ago	15.4	14.6	28.7	15.6E**
Never smoker†	50.5	39.1**	25.0	26.4
Leisure-time physical activity				
Inactive†	63.6	66.4	58.7	58.4
Moderately active	22.5	21.4	22.5	20.3
Active	13.9	12.3	18.8	21.3E
Non-leisure physical activity	79.3	74.8	78.4	71.8
Alcohol use				
Never drank†	13.0	7.1E**	5.3	F
Light drinker	41.6	50.5*	32.2	34.2
Moderate drinker‡	29.3	25.5	40.6	39.8
Heavy drinker	...	...	9.0	7.1E
Former drinker	16.0	16.7	12.7	14.5E
Hormone replacement therapy in past month	13.0	20.9*	...	...
Antidepressant use in past month	2.9	17.5**	1.0E	7.5E*

† reference category
‡ For women, moderate and heavy drinkers were grouped because of small number who were heavy drinkers.
* significantly different from estimate for group of the same sex without depression ($p<0.05$)
** significantly different from estimate for group of the same sex without depression ($p<0.001$)
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published (coefficient of variation greater than 33.3%)
... not applicable

Source: 1994/1995 to 2006/2007 National Population Health Survey (NPHS), longitudinal square file

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Parent and child reports of children's activity

by Fortune Sithole and Paul J. Veugelers

Abstract

Objective

This article compares child reports of their physical and sedentary activities with those of their parents.

Data and Methods

Data were obtained from the 2003 Children's Lifestyle and School-performance Study (CLASS), a survey of Grade 5 students and their parents in the province of Nova Scotia, Canada. Survey data with responses from Grade 5 students and their parents about the students' physical and sedentary activities were used. Agreement between the parent and child reports was evaluated with weighted kappa. Multilevel logistic regression was used to compare the parent and child reports in relation to the child body weight.

Results

Agreement between the 3,958 pairs of parent and child reports was low to fair. Relative to normal weight children, those who were overweight or obese reported more participation in organized and leisure sports and less time watching television than what their parents perceived. Unlike child self-reports, parent reports demonstrated statistically significant associations between the child's activities and body weight.

Interpretation

Based on these findings, parent reports seem to provide a more accurate assessment of activity levels of children younger than 12.

Keywords

data collection, sports, television, body weight, obesity, screen time

Authors

Fortune Sithole and Paul J. Veugelers (1-780-492-9095; paul.veugelers@ualberta.ca) are with the School of Public Health, University of Alberta, 13-106D Clinical Sciences Building, Edmonton, Alberta, Canada T6G 2G3.

Despite some contradictory results,[1-4] the relationship between physical activity and obesity has been established.[5-8] With the aim of providing direction for public health policies to prevent obesity, an increasing number of population-based studies now focus on determinants of activity, especially among children. Accurate assessment of physical and sedentary activity is essential to this research.

Population surveys use both child self-reports and parent proxy reports to quantify physical and sedentary activity in children and youth.[9,10] Both sources of information, however, have drawbacks. Children may be forgetful, and their perception and judgment of quantity and duration are not well developed. On the other hand, parents may not be fully aware of their children's activities. Whether self-reports from children or proxy reports from parents provide the best information has never been analyzed, although this would seem to be essential to the planning, implementation and interpretation of surveys.

National and other large-scale population surveys, which are generally conducted by telephone, cannot easily accommodate the use of instruments such as accelerometers and pedometers to measure physical activity. And while such instruments are objective, they have limitations; for example, they cannot be used in certain environments (some accelerometers cannot be worn underwater), and they create the potential for subject reactivity, especially in children.[11]

Another challenge in obesity research is selective under-reporting. This has been shown to be the case for energy and fat intake by overweight and obese individuals.[12] A similar bias may apply to physical and sedentary activities, but this has never been studied.

To be able to better interpret survey findings on children's activity levels, this study evaluates responses of children and their parents to questions about sports (organized and leisure), television viewing, and computer use and video games. Differences in responses of normal weight, overweight and obese children are assessed.

Methods

Study design

The study was approved by the Research Ethics Board of Dalhousie University (Halifax, Canada), where the research was undertaken. Data were obtained from the 2003 Children's Lifestyle and School-performance Study (CLASS), a survey of Grade 5 students and their parents in the province of Nova Scotia, Canada.[8] Students and their parents were asked about the students' physical and sedentary activities; validated questions from the National Longitudinal Survey of Children and Youth[13] were used. The physical activity questions related to the frequency with which the children played: 1) organized sports (with a coach or instructor), and 2) leisure sports (without a coach or instructor). The responses were grouped into three categories: a) never or almost never, b) about once a month, and c) more than once a week. The questions about sedentary activities concerned the number of hours per day: 1) watching television, and 2) using a computer or playing video games. Again, the responses were grouped into three categories: a) one hour or less, b) more than one to three hours, and c) more than three hours.

Of the 291 public schools in Nova Scotia with Grade 5 classes, 282 participated in the survey and distributed a questionnaire and consent form to the parents of their Grade 5 students. Parents were asked to complete the questionnaire at home. Parental consent was obtained for 5,517 students, for an average response rate of 51.1% per school.

Study representatives then visited the schools to administer the survey to students and to measure their height and weight. Standing height was measured to the nearest 0.1 cm after the children had removed their shoes. Weight was measured to the nearest 0.1 kg on calibrated digital scales. Normal weight, overweight and obese categories were defined using the international body mass index (BMI) cut-offs established for children and youth.[14] These cut-offs are based on health-related adult definitions of overweight (25 kg/m^2 or more) and obesity (30 kg/m^2 or more), adjusted to specific age and sex groups for children.[14] One of the seven provincial school boards did not allow measurement of height and weight. Students without height and weight measurements were excluded from this analysis, leaving a sample of 4,298 children from 242 schools.

Agreement

Since the responses to activity levels were ordered, the extent of agreement between the parent and child reports of the children's physical and sedentary activities was assessed with weighted kappa.[15] A user-defined weighting system of 1 (perfect agreement), 0.25 (difference of 1 category) and 0 (difference of 2 categories) was used. For each activity, kappa scores were determined for the study population at large, and separately, for normal weight, overweight and obese children.

Extent of agreement and association with body weight

The parent and child reports were grouped into three categories: 1) children reported less activity; 2) agreement; and 3) children reported more activity. The association between these categories and children's weight status was determined with multilevel multivariate logistic regression, which accounted for within-school clustering of children. The analysis was adjusted for child gender, parental income, and parental education.

Relationship between parent and child reports and child's body weight

In separate analyses, the predictive potential of parent and child responses about activity levels with regard to the child's weight status was compared using multilevel multivariate logistic regression, while adjusting for child gender, parental income, and parental education. These parent and child models were then compared with respect to: 1) the strength of the association between reported activities and weight status; 2) the statistical significance of these activities with weight status using the Wald statistic; and 3) how well the model explained body weight based on the Akaike Information Criterion (AIC),[16] an index used to identify the best-fitting of two parallel models.[16]

The analyses were based on 3,940 parent-child pairs for organized sports; 3,958 pairs for leisure sports; 3,925 pairs for television viewing; and 3,955 pairs for computer and video game time. The number of pairs differed because of missing data on the activity questions for children and/or parents. Stata 9 (StataCorp, College Station, Texas) was used for all the statistical analyses.

Results

Agreement no more than fair

The agreement (kappa score) between children and their parents about the extent of the children's participation in organized sports was 0.41 (Table 1), which is considered fair.[17] The kappa score for leisure sports was 0.11, which is considered low. The scores for television viewing and computer use/video games were 0.19 (low) and 0.23 (fair), respectively.

Children report more activity

Relative to their parents' perception, children reported significantly more hours of sedentary activities, with 34% reporting more television viewing and 33% reporting more computer use/video games (Table 2). Children also reported greater participation in physical activities, but these differences were not statistically significant (Table 2).

Children who reported more participation in organized and leisure sports than their parents were significantly more likely to be overweight or obese, compared with

Table 1
Agreement (measured using weighted Kappa) between parent and child reports of child's activities, by child's weight

Child's activities	Number of parent-child combinations	Child's weight: Total Kappa	Total 95% confidence interval	Normal weight Kappa	Normal weight 95% confidence interval	Overweight Kappa	Overweight 95% confidence interval	Obese Kappa	Obese 95% confidence interval
Organized sports	3,940	0.41	0.39 to 0.44	0.42	0.39 to 0.44	0.42	0.37 to 0.47	0.37	0.29 to 0.45
Leisure sports	3,958	0.11	0.08 to 0.14	0.09	0.06 to 0.13	0.16	0.09 to 0.23	0.11	0.01 to 0.25
Television viewing	3,925	0.19	0.16 to 0.21	0.20	0.18 to 0.24	0.16	0.10 to 0.21	0.10	0.03 to 0.18
Computer use and video games	3,955	0.23	0.20 to 0.25	0.23	0.19 to 0.25	0.22	0.17 to 0.26	0.25	0.16 to 0.33

Source: 2003 Children's Lifestyle and School-performance Study

children who agreed with their parents (Table 2). And for sedentary activities, children who reported fewer hours of television than their parents were significantly more likely overweight or obese than children whose estimates agreed with those of their parents. Findings were similar when normal weight children were compared with obese children rather than with those who were overweight (including obese) (data not shown).

Parent reports related to child's body weight

Children whose parents reported them participating in organized and leisure sports at least once a week were significantly less likely to be overweight or obese than were children whose parents said that they rarely engaged in these activities (Table 3). As well, children whose parents reported that they spent more than three hours a day watching television were significantly more likely to be overweight or obese than were children whose parents said that they devoted no more than an hour a day to television. By contrast, activity levels self-reported by children were not significantly associated with overweight/obesity. AIC values for parent models were lower than those for child models for each activity, indicating that parent reports better explained the variation in weight status than did child reports (Table 3). Results were similar when normal weight children were compared with obese children, and when the gender of the parent who completed the questionnaire was considered (data not shown).

Discussion

Children and parents who responded to the CLASS differed in their assessments of the children's activity levels. The children who reported more physical and less sedentary activity than what their parents perceived were more likely to be overweight or obese than were those who agreed with their parents. Unlike child self-reports, parent reports were consistent with the established association between greater physical activity and healthy weight.

A total of 19 studies of the association between activity and weight in children were reviewed. Of these, four were based on parent proxy reports,[6,10,18,19] and 15 on child self- reports.[1-5,9,16,20-27] The findings of each of the four studies based on parent reports[6,10,18,19] were consistent with the association between physical activity and weight. By contrast, four (27%) of the 15 studies based on child reports did not reveal

Table 2
Concurrence of parent and child reports of child's activities, and adjusted odds ratios relating reports of activity to overweight/obesity in child

Child's activities	Parent-child combinations: Number	Parent-child combinations: %	Child overweight/obesity: Adjusted odds ratio	Child overweight/obesity: 95% confidence interval
Organized sports				
Child reports less	618	16	0.90	0.74 to 1.10
Child reports same†	2,677	68	1.00	...
Child reports more	645	16	1.33*	1.11 to 1.60
Leisure sports				
Child reports less	292	7	0.86	0.65 to 1.13
Child reports same†	3,300	84	1.00	...
Child reports more	366	9	1.39*	1.11 to 1.74
Television viewing				
Child reports less	723	18	1.24*	1.04 to 1.49
Child reports same†	1,885	48	1.00	...
Child reports more	1,317	34	1.04	0.89 to 1.21
Computer use and video games				
Child reports less	556	14	1.07	0.87 to 1.31
Child reports same†	2,089	53	1.00	...
Child reports more	1,310	33	0.95	0.82 to 1.11

† reference category
‡ adjusted for child gender, parental income and parental education
* significantly greater odds of being overweight or obese compared with reference category ($p < 0.05$)
... not applicable
Source: 2003 Children's Lifestyle and School-performance Study

Table 3
Adjusted odds ratios relating child overweight/obesity to parent and child reports of child's activities

	Child overweight/obesity				
Child's activities	Adjusted‡ odds ratio based on parent report	95% confidence interval	Adjusted‡ odds ratio based on child report	95% confidence interval	AIC§ (parent minus child)
Organized sports					
Almost never†	1.00	...	1.00	...	
Once per month	0.87	0.66 to 1.17	1.00	0.80 to 1.25	
At least once per week	0.72*	0.62 to 0.85	0.97	0.81 to 1.15	
	p-value < 0.01††		p-value = 0.89††		-253
Leisure sports					
Almost never†	1.00	...	1.00	...	
Once per month	0.86	0.57 to 1.23	0.81	0.50 to 1.33	
At least once per week	0.63*	0.47 to 0.85	0.89	0.58 to 1.34	
	p-value < 0.01††		p-value = 0.70††		-11
Television viewing					
One hour or less a day†	1.00	...	1.00	...	
More than 1 to 3 hours a day	1.20	0.96 to 1.49	1.21	0.97 to 1.50	
More than 3 hours a day	1.68*	1.32 to 2.14	1.30*	1.05 to 1.61	
	p-value < 0.01††		p-value = 0.06††		-19
Computer use and video games					
One hour or less a day†	1.00	...	1.00	...	
More than 1 to 3 hours a day	1.15	0.99 to 1.33	0.96	0.83 to 1.12	
More than 3 hours a day	1.23	0.91 to 1.64	1.01	0.83 to 1.23	
	p-value < 0.01††		p-value = 0.84††		-4

† reference category
‡ adjusted for child gender, parental income and parental education
§ Akaike Information Criterion: negative values (parent AIC minus student AIC) indicate that parent reports provide model with better fit than child model
†† p-value based on Wald statistic; values below 0.05 indicate statistically significant improvement of model if activity covariate is added to model
* significantly different from reference category ($p < 0.05$)
... not applicable
Source: 2003 Children's Lifestyle and School-performance Study

such an association. This percentage may be even higher than 27% due to publication bias, whereby studies with positive findings are more likely to be published than are those that fail to reveal an association. Of the four studies based on parent reports, three pertained to children aged 4 to 7,[6,10,19] and one, to children aged 8 to 12.[18] The 15 studies based on child self-reports[1-5,9,16,20-27] concerned child-ren of at least 8 years of age; thirteen of these studies included 10- and 11-year-olds, the ages of the children in the present analysis.

A "social desirability bias" may apply to the findings from the CLASS. Despite the apparently evident causal relationship between high calorie consumption and overweight,[28-30] various studies have failed to confirm it.[31-33] Investigators have suggested that under-reporting of food intake by overweight individuals accounts for this failure, and refer to this tendency as "social desirability bias." The present study shows that such a bias may also apply to the reporting of activity, as children who reported more physical and less sedentary activity than was perceived by their parents were more likely to be overweight or obese than were children who agreed with their parents. (Selective under-reporting of physical activity by parents of overweight children may also contribute to this observation.) Social desirability bias would be best demonstrated in a validation study comparing child self-reports with an objective measure of physical activity, but we are not aware of the existence of such a study.

The limitations of self- and proxy reports of activity are evident—they are subjective and require judgment about the quantity and duration of activities. Nonetheless, public health researchers recognize advantages of self-reports over measurements from instruments such as pedometers and accelerometers. Self-reports are more convenient for large population-based surveys: particiipation rates are higher, and costs are lower. And compared with the step-counts obtained from pedometers, the data derived from self-reports of participation in various activities translate more easily into public health policy recommendations such as support for organized sports facilities or for safe neighborhoods in which children can play.

This analysis used the relationship between activity and weight to assess the accuracy of parent and child reports. Though not a conventional method of validation, it is a logical way of comparing reports of activity levels, particularly in a large-scale population-based survey like the CLASS that used questionnaires. Moreover, weight status in this study was objective, as height and weight were directly measured.[34,35] The parent reports were consistent with the relationship between activity and weight status, suggesting that they may be more accurate than self-reports by children of these ages.

In summary, children and parents differed in their perceptions of the children's activity. Children who reported more physical activity but less sedentary activity than their parents were more likely to be overweight or obese than were children whose accounts agreed with those of their parents. These results, of course, are based on only one study of children in one elementary grade in a province of Canada. Additional research is needed to confirm that parent reports are more reliable assessments of children's activities than are those of the children themselves.

Acknowledgements

We thank the Grade 5 students, their parents and the schools for their participation in the CLASS project. We are grateful to the research assistants and public health staff who participated in data collection. The research was funded by a Canadian Population Health Initiative operating grant and through a Canada Research Chair in Population Health awarded to Dr. Paul Veugelers. We thank Statistics Canada for allowing us to use questions from the National Longitudinal Survey of Children and Youth.

References

1. Hernandez B, Gortmaker SL, Colditz GA, et al. Association of obesity with physical activity, television programs and other forms of video viewing among children in Mexico city. *International Journal of Obesity-Related Metabolic Disorders* 1999; 23(8): 845-54.
2. McMurray RG, Harrell JS, Deng S, et al. The influence of physical activity, socioeconomic status, and ethnicity on the weight status of adolescents. *Obesity Research* 2000; 8(2):130-9.
3. Robinson TN, Hammer LD, Killen JD, et al. Does television viewing increase obesity and reduce physical activity? Cross-sectional and longitudinal analyses among adolescent girls. *Pediatrics* 1993; 91(2): 273-80.
4. Vandewater EA, Shim MS, Caplovitz AG. Linking obesity and activity level with children's television and video game use. *Journal of Adolescence* 2004; 27(1): 71-85.
5. Janssen I, Katzmarzyk PT, Boyce WF, et al. Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. *Obesity Reviews* 2005; 6(2): 123-32.
6. Janz KF, Levy SM, Burns TL, et al. Fatness, physical activity, and television viewing in children during the adiposity rebound period: the Iowa Bone Development Study. *Preventive Medicine* 2002; 35(6): 563-71.
7. Shields M. Overweight and obesity among children and youth. *Health Reports* (Statistics Canada, Catalogue 82-003) 2006; 17(3): 27-42.
8. Veugelers PJ, Fitzgerald AL. Prevalence of and risk factors for childhood overweight and obesity. *Canadian Medical Association Journal* 2005; 173(6): 607-13.
9. Koezuka N, Koo M, Allison KR, et al. The relationship between sedentary activities and physical inactivity among adolescents: Results from the Canadian Community Health Survey. *Journal of Adolescent Health* 2006; 39: 515-22.
10. Tremblay MS, Willms JD. Is the Canadian obesity epidemic related to physical inactivity? *International Journal of Obesity* 2003; 27: 1100-5.
11. Esliger DW, Copeland JL, Barnes JD, et al. Standardizing and optimizing the use of accelerometer data for free-living physical activity monitoring. *Journal of Physical Activity and Health* 2005; 3: 366-83.
12. Heitmann BL, Lissner L. Dietary underreporting by obese individuals—is it specific or non-specific? *British Medical Journal* 1995; 311(7011): 986-9.
13. Statistics Canada. National Longitudinal Survey of Children and Youth (NLSCY). Available at: www.statcan.ca/cgibin/imdb/p2SV.pl?Function=getSurvey&SDDS=4450&lang=en&db=IMDB&dbg=f&adm=8&dis=2. Accessed July 26, 2005.
14. Cole TJ, Bellizzi MC, Flegal KM, et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal* 2000; 320(7244): 1240-3.
15. Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements. *Physical Therapy* 2005; 85(3): 257-68.
16. Dohoo I, Martin W, Stryhn H. *Veterinary Epidemiologic Research*. Charlottetown, PEI, Canada: AVC Inc., 2003.
17. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; 33(1): 159-74.
18. Epstein LH, Paluch RA, Gordy CC, et al. Decreasing sedentary behaviors in treating pediatric obesity. *Archives of Pediatrics and Adolescent Medicine* 2000; 154(3): 220-6.
19. Graf C, Koch B, Dordel S, et al. Physical activity, leisure habits and obesity in first-grade children. *European Journal of Cardiovascular Prevention and Rehabilitation* 2004; 11(4): 284-90.
20. Deforche B, Lefevre J, De Bourdeaudhuij I, et al. Physical fitness and physical activity in obese and nonobese Flemish youth. *Obesity Research* 2003; 11(3): 434-41.
21. Dowda M, Ainsworth BE, Addy CL, et al. Environmental influences, physical activity, and weight status in 8- to 16-year-olds. *Archives of Pediatrics and Adolescent Medicine* 2001; 155(6): 711-7.
22. Eisenmann JC, Bartee RT, Wang MQ. Physical activity, TV viewing, and weight in U.S. youth: 1999 Youth Risk Behavior Survey. *Obesity Research* 2002; 10(5): 379-85.
23. Gordon-Larsen P, Adair LS, Popkin BM. Ethnic differences in physical activity and inactivity patterns and overweight status. *Obesity Research* 2002; 10(3): 141-9.

24. Janssen I, Katzmarzyk PT, Boyce WF. Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *Journal of Adolescent Health* 2004; 35(5): 360-7.

25. Lowry R, Wechsler H, Galuska DA, et al. Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegetables among US high school students: differences by race, ethnicity, and gender. *Journal of School Health* 2002; 72(10): 413-21.

26. Tanasescu M, Ferris AM, Himmelgreen DA, et al. Biobehavioral factors are associated with obesity in Puerto Rican children. *Journal of Nutrition* 2000; 130(7): 1734-42.

27. Wolf AM, Gortmaker SL, Cheung L, et al. Activity, inactivity, and obesity: racial, ethnic, and age differences among schoolgirls. *American Journal of Public Health* 1993; 83(11): 1625-7.

28. Berkey CS, Rockett HR, Field AE, et al. Activity, dietary intake, and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics* 2000; 105(4): E56.

29. Maffeis C, Provera S, Filippi L, et al. Distribution of food intake as a risk factor for childhood obesity. *International Journal of Obesity and Related Metabolic Disorders* 2000; 24(1): 75-80.

30. McGloin AF, Livingstone MB, Greene LC, et al. Energy and fat intake in obese and lean children at varying risk of obesity. *International Journal of Obesity and Related Metabolic Disorders* 2002; 26(2): 200-7.

31. Atkin LM, Davies PS. Diet composition and body composition in preschool children. *American Journal of Clinical Nutrition* 2000; 72(1): 15-21.

32. Kimm SY. The role of dietary fiber in the development and treatment of childhood obesity. *Pediatrics* 1995; 96(5 Pt 2): 1010-4.

33. Maffeis C, Talamini G, Tato L. Influence of diet, physical activity and parents' obesity on children's adiposity: a four-year longitudinal study. *International Journal of Obesity and Related Metabolic Disorders* 1998; 22(8): 758-64.

34. Elgar FJ, Roberts C, Tudor-Smith C, et al. Validity of self-reported height and weight and predictors of bias in adolescents. *Journal of Adolescent Health* 2005; 37(5): 371-5.

35. Niedhammer I, Bugel I, Bonenfant S, et al. Validity of self-reported weight and height in the French GAZEL cohort. *International Journal of Obesity and Related Metabolic Disorders* 2000; 24(9): 1111-8.

The Canadian census mortality follow-up study, 1991 through 2001

by Russell Wilkins, Michael Tjepkema, Cameron Mustard and Robert Choinière

Abstract

Background

An important step in monitoring progress toward reducing or eliminating inequalities in health is to determine the distribution of mortality rates across various groups defined by education, occupation, income, language, ethnicity, and Aboriginal, visible minority and disability status. This article describes the methods used to link census data from the long-form questionnaire to mortality data, and reports simple findings for the major groups.

Data and methods

Mortality from June 4, 1991 to December 31, 2001 was tracked among a 15% sample of the adult population of Canada, who completed the 1991 census long-form questionnaire (about 2.7 million, including 260,000 deaths). Age-specific and age-standardized mortality rates were calculated across the various groups, as were hazard ratios and period life tables.

Results

Compared with people of higher socio-economic status, mortality rates were elevated among those of lower socio-economic status, regardless of whether status was determined by education, occupation or income. The findings reveal a stair-stepped gradient, with bigger steps near the bottom of the socio-economic hierarchy.

Keywords

age-standardized mortality rates, longitudinal, non-institutional, proportional hazards, record linkage, socio-economic, survival analysis

Authors

Russell Wilkins (1-613-951-5305; Russell.Wilkins@statcan.gc.ca) is with the Health Information and Research Division at Statistics Canada, Ottawa, Ontario K1A 0T6; Michael Tjepkema (1-416-952-4620; Michael.Tjepkema@statcan.gc.ca) is with the Health Information and Research Division at Statistics Canada in Toronto, Ontario; Cameron Mustard is with the Institute for Work and Health and the University of Toronto, Toronto, Ontario; and Robert Choinière is with the Institut national de santé publique du Québec, Montreal, Quebec.

A goal of Canadian health policy is to reduce or eliminate socio-economic inequalities in health.[1] An important step in achieving this goal is to determine the distribution of health status across groups defined by income, education, occupation, language and ethnicity, Aboriginal or visible minority status, and disability status. Each of these characteristics must be directly addressed in terms of the most fundamental aspects of health: life or death, and relative risks of premature death from various causes.

Several countries have undertaken large, nationally representative population-based cohort studies of mortality by socio-economic status (usually by linking to national censuses and population registries): the United States,[2-5] the United Kingdom or England and Wales,[6-9] Scotland,[10] France,[11-16] Finland,[17-19] Denmark,[20-22] Sweden,[23-25] Norway,[26-29] Italy,[30] Spain,[31] Switzerland,[32-34] Belgium,[35] Austria,[36] Lithuania,[37] Israel,[38] and New Zealand.[39] These studies have mainly investigated differences by education and occupation, and have consistently shown lower education levels and lower-status occupational categories (and the economically inactive) to have the highest mortality rates, and higher educational levels and higher status occupational categories (managerial and professional) to have the lowest mortality rates. Increasingly, researchers have analysed such disparities from a cause-specific and often international perspective[40] (breast cancer,[41,42] lung cancer,[43] alcohol-related diseases,[44,45] stroke,[46] ischaemic heart disease,[47] all cardiovascular diseases,[48,49]) or by age group (the middle-aged[50] and elderly[51]).

In Canada, no nationally representative population-based cohort studies have examined mortality by socio-economic status in the total population. Instead, several record-

linkage-based mortality follow-up studies starting from selected samples of (or from administrative data files about) the general population have been conducted.[52-64] While these studies have contributed to our knowledge of socio-economic differentials in mortality in Canada, their generalizability is limited by the scope of the universe covered (for example, geographically or by age, sex and/or occupation), small sample sizes, lack of information about cause of death, or a combination of these constraints.

In response to these limitations in existing information, a database linking census data from the long-form questionnaire to mortality data was created to develop a set of baseline indicators of mortality to monitor health disparities in Canada. More specifically, the goal was to facilitate analyses of mortality and causes of death by indicators of social position, occupation and industry, ethnicity, birthplace and other socio-demographic variables, and multi-level analyses of those effects, including local area variations. This report describes the methods used to create the database and highlights some initial findings that illustrate the breadth and depth (and research potential) of the database. Because of the richness of the census long-form questionnaire, this study is able to provide baseline information on mortality across a wide range of individual, family, household and neighbourhood characteristics.

Methods

Mortality was tracked for more than a decade among a 15% sample of the adult population of Canada (some 2.7 million) who completed the 1991 census long-form questionnaire. During the follow-up period (June 4, 1991 to December 31, 2001), there were over 260,000 deaths in the sample.

The study was approved by the Statistics Canada Policy Committee[65] after consultations with the Statistics Canada Confidentiality and Legislation Committee, the Data Access and Control Services Division, and the Federal Privacy Commissioner. It was approved by the Research Ethics Committee of the University of Toronto, and was peer-reviewed by the Canadian Population Health Initiative, the Canadian Institutes of Health Research, and the Research Advisory Council of the Ontario Workplace Safety and Injury Board. It was also internally reviewed by the Institut national de santé publique du Québec, the Institute for Work and Health, and the Health Statistics Division of Statistics Canada.

Linking to the "bridge" file

The electronic files of census data contained no names, but names were needed to find the corresponding deaths. Therefore, the first link was to a nominal list (name) file to bridge between the census and the deaths files.

Names were encrypted before linking and were not retained on the analysis file. The name file was abstracted from tax-filer data from 1990 and 1991 (from filings typically submitted in April 1991 and April 1992—either about two months before or 10 months after the 1991 census day, June 4). The name file also contained date of birth and postal code, plus spousal (including common-law partner) date of birth. Spousal records were first matched (using encrypted social insurance numbers), and the additional information about the other spouse was copied to the record of each spouse. The nominal list file records for the same person for the two years were then compared. Changes detected in postal code, dates, marital status or names (such as from maiden to married name) resulted in the generation of additional, alternative records for such cases, so that subsequent matches could be made to the best-fitting record.

Probabilistic record linkage from the census file to the name file was then carried out. It was based mainly on dates of birth and postal codes (of both spouses, if applicable). Since most people on the name file would *not* have completed a long-form census questionnaire (administered to only a 20% sample of households), and since we wanted to minimize false positive links, deterministic matching was first done from the entire census universe to the name file. (However, because postal codes had not been captured from the short form census records, postal codes were first imputed for the short-form records from the postal code(s) of the nearest neighbours [higher or lower household numbers in the same enumeration area] with a captured postal code. If the postal codes of the two donor households differed, both were retained on alternate records.) People on the name file who were better matched to a census short form record were not "in scope," and were removed from consideration as potential members of the cohort. This process minimized the possibility of false positive links to persons on the name file who were not eligible to be part of the cohort followed for mortality.

Using probabilistic record linkage techniques,[66] the in-scope census records (N=3,576,487 from long-form questionnaires for people aged 25 or older) were then matched to the remaining records on the name file. Overall, 80% (N=2,860,244; the "response" rate) of the in-scope census records were matched to the name file. Details of the matching success, which varied by socio-economic characteristics, are presented in the Results section. The accuracy of the linkage from the census in-scope records to the name file was also evaluated. Based on a manual search of a stratified random sample of the manuscript census questionnaires, 99% of the matches were determined to be good matches—that is, to the correct person.

Cohort membership

Individuals were eligible to be part of the study cohort if they were usual residents of Canada on the day of the census, were in the long-form census records, and had attained age 25 by census day. These were the 3.6 million "in-scope" persons shown in Table 1.

But among eligible persons, only those matched to a name record could be reliably followed for mortality. Matching to a name record was attempted only for people with at least a reported year of birth (unimputed) and a postal code (reported or imputed, since imputed postal codes were mostly of high quality). Of the in-scope census records, 716,243 (or 20%) could not be linked to the name file.

To be considered an institutional resident (inmate), and thus not eligible for cohort membership, a person living in an institution on census day must have had no other residence in Canada, or have been living at the institution for at least six months. Thus, people experiencing short-term episodes of hospitalisation or incarceration were not considered institutional residents and were eligible to be part of the study cohort if their household received a long-form census questionnaire.

Only people who were counted by the census could be part of the cohort. Data quality reports found that the 1991 census missed 3.43% of the Canadian population of all ages, an estimated 965,000. The missed individuals were more likely to be young, mobile, low income, of Aboriginal ancestry,[67] or homeless.

As reported above, 2,860,244 persons were both eligible to be in the cohort, and were successfully linked to the name file. However, to reduce the size of the final cohort to equal 15% of the Canadian population aged 25 or older (18.2 million), about 4.4% (125,092 person records) of the sample who could have been followed were randomly removed, leaving 2,735,152 people in the cohort. Thus, the final ratio of the cohort to the "in-scope" population of interest was 76% (approximately 3 out of 4 census long-form respondents).

Linking to the death file

Only census records that could be "bridged" to the name file (which had been abstracted from non-financial tax-filer data) could be reliably followed for mortality using the Canadian Mortality Database. Except for encryption and the large size of the cohort, the methods of probabilistic record linkage[66] for the mortality follow-up were nearly the same as those routinely employed for mortality follow-up studies at Statistics Canada.[68]

Table 1
Derivation of cohort from in-scope census records, and cohort as percentage of 1991 population aged 25 or older, Canada

	Number
Derivation of cohort	
In-scope census records (residents of Canada aged 25 or older with long-form questionnaire)	3,576,487
Not linked to name file	716,243
Linked to name file	2,860,244
Linked to name file, but not followed for deaths*	125,092
Linked to name file and followed for deaths (the cohort)	2,735,152
Percentage of population	
1991 mid-year population estimate for all Canada, population aged 25 or older†	18,225,349
Cohort as percentage of population aged 25 or older (%)	15.0

* simple random sample of 4.4% of those linked to name file
† CANSIM table 051-0001/3604
Source: Census mortality follow-up study, 1991 to 2001.

Content of the analysis file

For cohort members, the linked file contained data from the long-form census questionnaires, and where applicable, data from the post-censal Health and Activity Limitation Survey,[69] and death data from Canadian vital statistics. Nearly all of the 1991 census long-form content was available, including education, occupation, income, visible minority and Aboriginal status (mainly based on ethnicity of ancestors), place of birth, language (mother tongue, home languages, knowledge of official languages), place of residence, mobility, marital status, living arrangements, housing, place of work, and activity limitations. Death data included underlying cause of death (previously coded) and date of death. Records from responses to the 1991 Health and Activity Limitation Survey (HALS) had previously been linked to census long-form records, and this study had approval to use those data. As a result, for cohort members who were also part of that survey (N=17,132), information from the HALS was available for analysis, but is not reported here. Information from the 1991 post-censal Aboriginal Peoples Survey (APS) was not included in this study.

Mortality analyses

For each member of the cohort, person-days of follow-up were calculated from the beginning of the study (June 4, 1991) to the date of death, emigration (ascertained from the name file and known for 1991 only), or end of the study (December 31, 2001). Person-days of follow-up were then divided by 365.25 to get person-years at risk.

For each single year of age (at the time of the census) and sex, the proportion of the initial cohort surviving (not known to have died or emigrated) was calculated to the end of the study period (10.6 years), and compared with the proportion of the total population expected to survive 10.6 years, by single-year-of-age and sex, according to the 1995 to 1997 life tables for Canada.[70] The number of deaths in the cohort was also compared with the number expected, based on mortality rates for the non-institutional population of urban Canada.[71]

Age- and sex-specific mortality rates by 5-year age groups (at baseline) were used to calculate age-standardized mortality rates (ASMRs) for subgroups of the population, using the cohort population structure (person-years at risk), both sexes together, as the standard population. Corresponding 95% confidence intervals (CIs) for the

ASMRs were calculated as described by Carrière and Roos.[72] A similar method was used to calculate the ASMR rate differences (RD) and rate ratios (RR) and their 95% CIs.

For age-specific analyses, cohort members were categorized by 10-year age groups from 25-to-34 to 75-to-84, and 85 or older. The mortality rates within each age group were age-standardized using 5-year age groups. For example, the mortality rate in the 25-to-34 age group was age-standardized using the cohort age distribution for 25-to-29- and 30-to-34-year-olds. Most analyses used age at baseline (June 4, 1991), while supplemental analyses used age at the beginning of each year of follow-up (for period life tables and related statistics).

For Aboriginal results, standardization for the ASMRs used the age distribution (person-years at risk) of Aboriginal cohort members rather than that of all cohort members. This was done because the Aboriginal population was much younger than other Canadians, and age-standardizing to the entire cohort population would give undue influence to the older ages. As well, because there was a notable cross-over of mortality rates in the upper age groups (with lower age-specific rates for older Aboriginal persons of both sexes, and much higher rates among younger Aboriginal persons), using the Aboriginal population as the standard provided a clearer picture of the impacts of those differentials on overall Aboriginal mortality.

Mortality hazard ratios adjusted for age and corresponding 95% CIs were calculated for each of the various categories of socio-economic characteristics (coded as indicator or "dummy" variables), using Cox proportional hazard regression. Age in completed years on census day was included as a variable in all models (so that age had an exponential effect on the hazard). Separate models were run for men and women. All such computations were performed using the PHREG procedure in the Statistical Analysis System (SAS) Version 9.1 for Windows (SAS Institute, Cary North Carolina).

Period life tables for each sex and major socio-economic grouping, plus corresponding standard errors and 95% CIs were calculated according to the method of Chiang.[73] These calculations were done after age was transformed from age at baseline to age at the beginning of each year of follow-up, and deaths and person-years at risk were calculated separately for each year (or partial year) of follow-up. Deaths and person-years at risk were then pooled by age at the beginning of each year of follow-up, before the calculation of the life tables. Life tables for both sexes together were constructed by combining the columns for survivors and life years lived from the life tables for each sex, rather than by using mortality rates based on pooled death and population data. This ensured that the actual distribution of the population by age and sex would have no effect on the life table results.

The underlying cause of death of those who died during the study period had been previously coded to the World Health Organization's *International Classification of Diseases, Ninth Revision* (ICD-9)[74] for deaths occurring in the period 1991 through 1999, and to the *Tenth Revision* (ICD-10)[75] for deaths occurring in 2000 or 2001. For analyses by cause of death, deaths were first grouped broadly by ICD chapter (based on ICD-9 or ICD-10 equivalent), and then more specifically according to cause groupings established by the Public Health Agency of Canada (formerly the Laboratory Centre for Disease Control (LCDC) cause of death categories). For 418 deaths that were identified through the name file but not linked in the vital statistics death records, the cause was unknown. Three other deaths were linked on the vital statistics death records, but without any stated cause. Those 421 deaths were retained in the database, but with cause of death set to "missing." Information on contributing causes of death was not recorded on the Canadian Mortality Data Base. Analyses by cause of death are not reported here, but will be in subsequent reports.

Definitions

Socio-economic characteristics

Highest level of education was grouped into four categories: less than secondary graduation, secondary graduation (or trades certificate), postsecondary certificate or diploma (short of a university bachelor's degree), and university degree (bachelor's or higher).

The socio-economic status of occupations (coded to the 4-digit National Occupational Classification) was ranked according to Boyd-NP scores,[76] which are based on the aggregate census data for the income and education of all persons with a given occupation. Boyd-NP scores are akin to the more familiar Blishen Index,[77] but are based on 1991 (and subsequent censuses) rather than on 1981 census data. For the entire non-institutional census target population aged 25 or older (the in-scope population), quintiles of population ranked by Boyd-NP score were constructed, first nationally, and also within each area. Areas were defined as census metropolitan area (CMA), census agglomeration (CA), or provincial or territorial residual area not in any CMA or CA (rural and small-town Canada). Because the differences in mortality between quintiles were more pronounced using the area-based quintiles, only those results are shown.

The socio-economic status of each occupation was also ranked according to five broad skill levels derived from the coding structure of the National Occupational Classification as originally defined by Employment and Immigration Canada (according to the original alpha-numeric coding before renumbering by Statistics Canada): professional, managerial, skilled/technical/supervisory, semi-skilled, and unskilled. People without an occupation

were retained as a separate "no occupation" category.

Quintiles and deciles of population ranked by income adequacy were constructed. First, for each economic family or unattached individual, total pre-tax, post-transfer income from all sources was pooled across all family members, and the ratio of total income to the Statistics Canada low-income cut-off (LICO) for the applicable family size and community size group was calculated.[78] Thus, all members of a given family were assigned the same LICO ratio, which was calculated for all non-institutionalized persons (the in-scope population), including people living on Indian reserves. The non-institutional population was then ranked according to the LICO ratio, and quintiles and deciles of population were constructed, first nationally and also within each CMA/CA or rural and small-town area. The purpose of constructing the quantiles within each area was to take account of regional differences in housing costs, which are not reflected in the LICOs, and to permit comparisons across areas to be based on comparable proportions of population in each quantile. Since the differences in mortality between quantiles were more pronounced using the area-based quantiles, only those results are shown.

Because visible minority status based on self-identification was not available for the 1991 census, visible minority status was inferred from answers to ethnic origin questions about ancestry. For purposes of federal legislation (Employment Equity Act of 1986), Aboriginal peoples are not considered visible minorities unless they report ancestry placing them into one of the 11 official visible minority categories: Black; Chinese, Japanese, Korean (grouped as East Asian); Southeast Asian, Filipino, Other Pacific Islanders (grouped as Southeast Asian and Pacific); South Asian; Southwest Asian or Arab; Latin American; and multiple visible minorities.

The three main groups of Aboriginal peoples in Canada are North American Indians (First Nations), Métis (mixed Aboriginal and non-Aboriginal descendants of mostly French-speaking fur traders and settlers in Western Canada), and Inuit. The 1991 census did not ask respondents to self-identity as an Aboriginal person, if applicable. Instead, Aboriginal categories were derived from responses to questions on ethnic origin (ancestry), Registered or Treaty Indian status, and Band or First Nations membership.

For this report, disability status at baseline was derived from the four census long-form disability screening questions (activities limited at home; activities limited at school or work; limited in other activities; disabled or handicapped). Persons with a "yes" to any of those questions were considered disabled.

Mortality rates are presented by community size and metropolitan influence zone.[79] Metropolitan influence zones classify geographic areas based on the extent of commuting flows between rural and small-town areas (not in any CMA or CA, so population less than 10,000) and urban centres (CMA or CA, so population at least 10,000).

Results

Characteristics of the cohort

Overall, 2,735,152 adults aged 25 or older were successfully "bridged" to the name file and followed for mortality. The probability of a successful bridge linkage to the name file varied by an individual's characteristics. Table 2 shows the number of persons in the cohort by characteristics related to linkage success, the cohort as a percentage of the total "in-scope" population, and the number of in-scope persons not linked to the name file. The second-last column shows, for each category, the ratio of the percentage of the in-scope population which was not matched to the bridge file, compared with the percentage in the cohort followed for mortality. Categories with a ratio greater than 1 were more likely to be unmatched, and thus, unable to be followed. These included women (because they were less likely to be in the labour force), seniors aged 65 or older (more likely to be retired, and therefore, less likely to be tax-filers), people who were unmarried or not in a common-law union (fewer matching variables available), rural residents (postal codes less precise for matching purposes), movers in the previous year (more likely not to match on postal codes), people with less than secondary graduation (less likely to be employed), people not in the labour force (less likely to be tax-filers), people in the lowest income adequacy quintile (less likely to be tax -filers), and those with any Aboriginal ancestry.

Figure 1 shows, for each single year of age, the percentage of cohort members who survived from 1991 to the end of 2001 (approximately 10.6 years), compared with the expected percentage of survivors after 10.6 years based on the official Canada life tables for 1995 to 1997. For both sexes, until about age 75, the cohort and life table curves are very close and often nearly superimposed. At older ages, the cohort survival curve becomes noticeably higher than the life table survival curve, particularly for women. This is as expected, since the cohort excluded residents of institutions (most of whom were institutionalized because of failing health) and anyone who failed to file a 1990 or 1991 tax return (including people not in the labour force or chronically unemployed, and others with very low incomes)—all groups expected to have higher mortality. Based on comparisons with life table data for non-institutionalized persons in urban Canada,[71] ascertainment of deaths in the cohort followed for mortality was estimated to be approximately 97%.

Mortality differences

For both sexes and all age groups except the oldest (85 or older), the percentage of the cohort surviving from June 4, 1991 to the end of 2001 increased in each successively higher income

Table 2
Cohort followed and deaths ascertained, non-institutionalized population aged 25 or older at baseline, Canada, 1991 to 2001

Category	In-scope census respondents (A)	Persons in cohort (B)	(C)*	Cohort as % of total (B/A)	Persons not linked (D)	(E)*	Ratio (E/C)	Deaths
	number			%	number	%		number
Total	3,576,500	2,735,200	100	76	716,200	100	1.00	260,820
Sex								
Men	1,738,000	1,358,400	50	78	317,700	44	0.89	153,522
Women	1,838,500	1,376,800	50	75	398,500	56	1.11	107,268
Age group								
25 to 64	2,972,800	2,312,700	85	78	544,300	77	0.92	89,888
65 or older	603,700	422,500	15	70	161,900	23	1.46	170,932
Marital status								
Married or common-law	2,544,900	2,030,500	74	80	421,700	59	0.79	154,513
Not married	1,031,600	704,700	26	68	294,600	41	1.60	106,307
Residence								
Urban	2,682,600	2,085,400	76	78	501,600	70	0.92	194,652
Rural	893,900	649,700	24	73	214,600	30	1.26	66,168
Mobility								
Non-mover in last year	2,974,600	2,342,500	86	79	524,900	73	0.86	234,325
Mover in last year	499,900	350,400	13	70	133,400	19	1.45	16,831
Not applicable	102,000	42,200	2	41	57,900	8	5.24	9,664
Education								
Secondary graduation or more	2,225,300	1,781,700	65	80	362,200	51	0.78	105,222
Less than secondary graduation	1,351,200	953,500	35	71	354,100	49	1.42	155,598
Labour force participation								
In labour force	2,421,500	1,955,600	72	81	376,800	53	0.74	68,554
Not in labour force	1,155,000	779,500	28	67	339,500	47	1.66	192,226
Income adequacy quintile								
Quintile 1 - poorest	715,400	470,400	17	66	223,600	31	1.82	75,229
Quintile 2	715,500	531,100	19	74	159,900	22	1.15	66,402
Quintile 3	715,100	565,400	21	79	123,800	17	0.84	44,658
Quintile 4	715,300	580,800	21	81	108,100	15	0.71	37,938
Quintile 5 - richest	715,000	587,400	21	82	100,900	14	0.66	36,593
Aboriginal origins								
No Aboriginal origins	3,392,500	2,624,300	96	77	648,000	90	0.94	253,225
Any Aboriginal origins	184,000	110,800	4	60	68,200	10	2.35	7,595

* percent distribution of characteristic within each category
Note: Census population counts rounded to nearest 100.
Source: Census mortality follow-up study, 1991 to 2001.

adequacy quintile (data not shown). The differences across the quintiles increased with advancing age to a maximum at ages 65 to 74. However, among women aged 85 or older (and not living in an institution at baseline), the pattern was almost reversed, with the percentages surviving generally greater among those in the lower than the higher income quintiles.

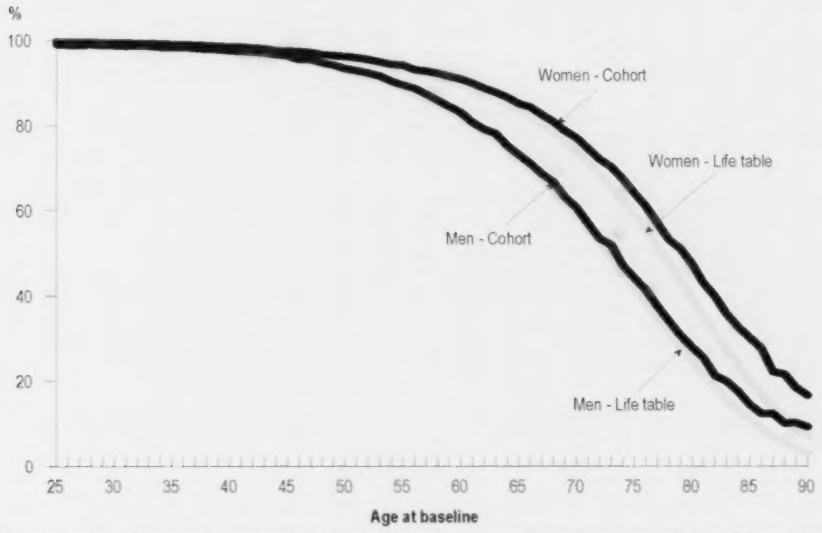
Remaining life expectancy at age 25 and the life table proportion expected to survive to age 75 are shown in Table 3 and Figures 2 and 3. For both sexes, life expectancy increased in each successively higher income quintile. The inter-quintile difference (Q5-Q1) in life expectancy was 6.8 years for men, and 4.3 years for women. The differences between the poorest and next-poorest quintiles (3.1 years for men, 2.3 years for women) were more than twice as large as the differences between the richest and next-richest quintiles (1.3 years for men, 0.6 years for women). For both sexes, the proportion expected to survive to age 75 also increased in each successively higher income quintile. Only 51% of men in the poorest quintile were expected to survive to age 75, compared with 72% of those in the richest quintile. The corresponding figures for women were 72% versus 84%.

Main findings

Table 4 (men) and Table 5 (women) show age-standardized mortality rates (ASMRs), rate ratios (RRs) and rate differences (RD) for the entire cohort aged 25 or older at baseline, by selected characteristics.

In the usual sequence of events, getting an education qualifies a person for an occupation, and working at an occupation provides an income. Consequently, the main findings are presented in that order. Many other

Figure 1
Percentage surviving 10.6 years, by age and sex, cohort followed for mortality from 1991 to 2001 versus all-Canada life tables for 1995 to 1997



Source: Census mortality follow-up study, 1991 to 2001; Statistics Canada, Life Tables – Canada, Provinces and Territories, 1995-1997 (Catalogue 84-537), 2002.[77]

Table 3
Remaining life expectancy at age 25 and percentage expected to survive to age 75, by income adequacy quintile and sex, non-institutionalized population aged 25 or older, Canada, 1991 to 2001

	Total			Men			Women		
		95% confidence interval			95% confidence interval			95% confidence interval	
Income adequacy quintile	years	from	to	years	from	to	years	from	to
Remaining life expectancy at age 25									
Total	55.8	55.8	55.9	52.6	52.6	52.7	59.0	58.9	59.1
Quintile 1 - poorest	52.4	52.3	52.5	48.4	48.3	48.6	56.4	56.3	56.5
Quintile 2	55.1	55.0	55.2	51.5	51.4	51.6	58.7	58.6	58.9
Quintile 3	56.3	56.2	56.4	53.0	52.9	53.2	59.5	59.4	59.7
Quintile 4	57.1	57.0	57.2	54.0	53.9	54.1	60.1	60.0	60.3
Quintile 5 - richest	58.0	57.9	58.1	55.3	55.2	55.4	60.7	60.5	60.8
Difference: Quintile 5 - Quintile 1	5.6	5.4	5.7	6.8	6.6	7.0	4.3	4.1	4.5
Percentage expected to survive to age 75	**%**	**from**	**to**	**%**	**from**	**to**	**%**	**from**	**to**
Total	71.5	71.3	71.6	64.0	63.8	64.2	79.0	78.8	79.2
Quintile 1 - poorest	61.0	60.7	61.4	50.6	50.1	51.1	71.5	71.0	71.9
Quintile 2	68.6	68.3	69.0	59.8	59.4	60.3	77.5	77.1	77.9
Quintile 3	72.7	72.4	73.0	64.9	64.4	65.3	80.6	80.2	81.0
Quintile 4	75.1	74.8	75.4	68.2	67.7	68.6	82.0	81.5	82.4
Quintile 5 - richest	78.1	77.8	78.4	72.4	72.0	72.8	83.8	83.4	84.2
Difference: Quintile 5 - Quintile 1	17.0	16.6	17.5	21.7	21.1	22.4	12.3	11.8	12.9

Source: Census mortality follow-up study, 1991 to 2001

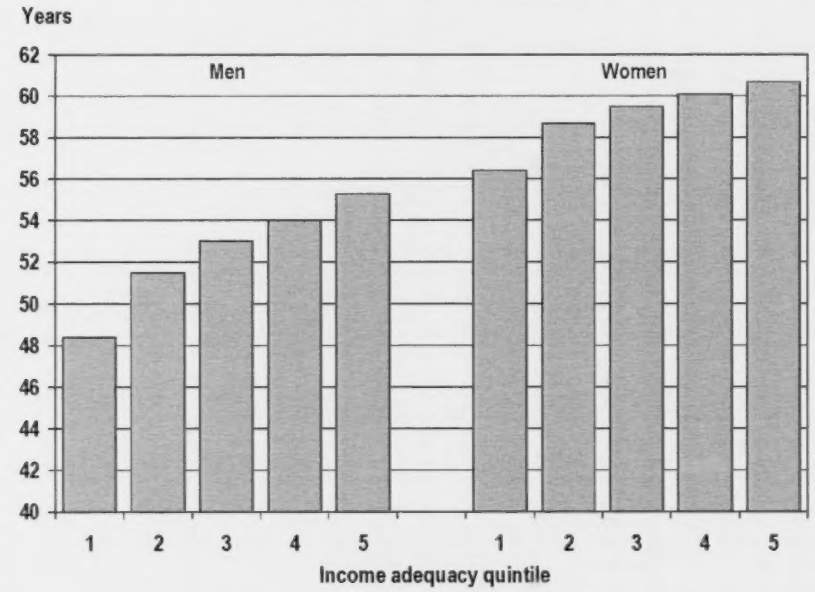
socio-economic variables were available, relating either to ascribed characteristics (determined at birth or infancy, and essentially unchangeable) or achieved characteristics (attained over the life course, and changeable). Ascribed characteristics included visible minority and Aboriginal status, place of birth and mother tongue. Achieved characteristics included knowledge of official languages, place of residence, mobility, marital status and living arrangements. Activity limitations could have existed at birth or developed later.

Education

The first panel of Tables 4 and 5 shows results by educational attainment. ASMRs were lowest among people with a university degree and highest for those with less than secondary graduation. A linear relationship was evident, with mortality rates increasing at successively lower levels of education. The mortality gradient was steeper for men than women.

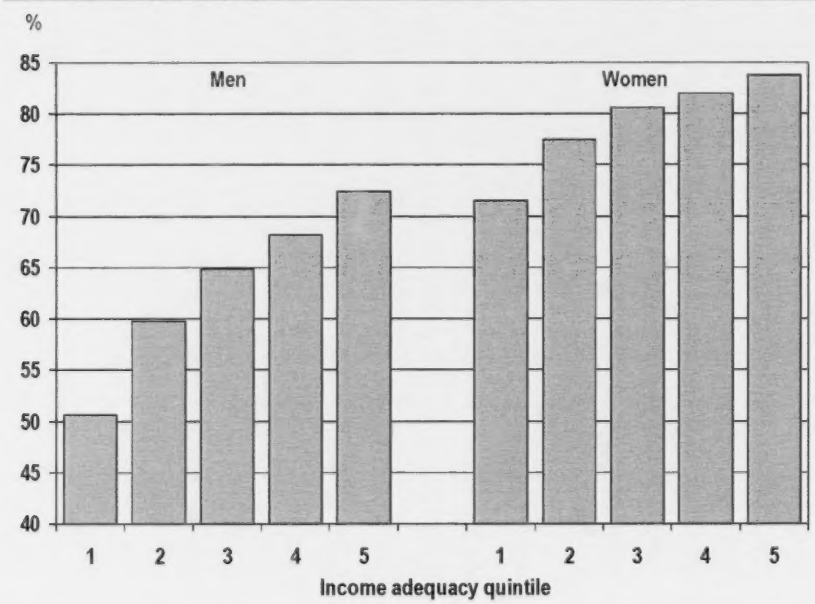
Appendix Table A shows RRs by education, by 10-year age group at baseline. The RRs are based on ASMRs calculated for each age group. For both sexes and for all except the oldest age group (85 or older), mortality rates were highest among those with the least education, and dropped with each increment of attainment. As well, RRs were highest in the youngest age groups and diminished with advancing age, as previously reported in a small pilot study for Manitoba.[80] For the oldest age group, the pattern by education was reversed, so that the point estimates of most RRs were below that of the reference group (university degree), especially for women, although none of these was statistically significantly different from 1. Mortality rates among people aged 85 or older at baseline could be calculated only for those who had survived to that age and were not institutionalized at the time of the census. (Appendix Table B shows hazard ratios corresponding to the RRs of Appendix Table A. The results are similar, but the proportional hazard modelling used

Figure 2
Life expectancy at age 25, by sex and income adequacy quintile, non-institutionalized population aged 25 or older at baseline, Canada, 1991 to 2001



Source: Census mortality follow-up study, 1991 to 2001.

Figure 3
Percentage expected to survive to age 75, by sex and income adequacy quintile, non-institutionalized population aged 25 or older at baseline, Canada, 1991 to 2001



Source: Census mortality follow-up study, 1991 to 2001.

in Appendix Table B does not produce absolute rates or rate differences.)

Occupation-based socio-economic groupings

ASMRs by sex for each quintile of the population with an occupation (ranked according to its Boyd-NP socio-economic score),[76] are shown in the second panel of Tables 4 and 5. ASMRs were lowest in the highest quintile (occupations with the highest socio-economic ranking). The gradients were not as steep as those for education and did not necessarily increase across each successive quintile. For example, the ASMRs were similar for quintiles 1, 2 and 3 among employed men, and for quintiles 1 and 2 among employed women. People without an occupation had much higher ASMRs, compared with even the lowest ranked quintile with any occupation.

A clearer pattern was evident for occupational categories ranked by skill level, as shown in the third panel of Tables 4 and 5. ASMRs for people with an occupation were lowest among professionals and highest among those in unskilled occupations. For men, ASMRs rose with each decrease in skill level (though the difference between adjacent categories was not always significant). For women, RRs were similar for all skill levels except unskilled occupations (RR of 1.34 compared with professionals).

In general, for people aged 25 to 75 at baseline, compared with professional occupations, RRs were higher for all other categories of occupations (second panel of Appendix Table A). The gradient was stronger in younger than older age groups. For the unskilled occupations, the RR was highest in the 35-to-44 age group for both sexes (but with a stronger effect for men). Particularly noteworthy were the RRs for men in age groups younger than 55 and without an occupation, reaching a high of 6.2 among those aged 35 to 44 at baseline. RRs among women without an occupation were elevated, but not nearly as much.

Table 4
Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized men aged 25 or older at baseline, Canada, 1991 to 2001

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Education											
University degree†	204,700	11,100	900.9	882.9	919.2	1.00	...	...	0.0	...	...
Postsecondary diploma	168,300	9,279	1,017.4	994.4	1,040.9	1.13	1.10	1.16	116.5	87.0	146.0
Secondary graduation	510,500	42,378	1,168.1	1,156.4	1,180.0	1.30	1.27	1.33	267.2	245.6	288.9
Less than secondary graduation	474,900	90,795	1,392.0	1,382.7	1,401.4	1.55	1.51	1.58	491.1	470.7	511.5
Occupation: Boyd-NP socio-economic quintile											
Quintile 5 - highest†	255,200	9,879	877.6	847.7	908.6	1.00	...	...	0.0	...	...
Quintile 4	242,400	10,814	940.2	910.5	970.8	1.07	1.02	1.12	62.5	19.7	105.3
Quintile 3	184,000	9,029	1,037.6	1,002.1	1,074.4	1.18	1.13	1.24	160.0	112.7	207.2
Quintile 2	215,300	11,617	1,083.6	1,047.1	1,121.4	1.23	1.18	1.30	206.0	158.0	254.0
Quintile 1 - lowest	218,400	15,658	1,068.0	1,046.0	1,090.3	1.22	1.17	1.27	190.3	152.7	228.0
No occupation	243,000	96,555	1,836.2	1,813.4	1,859.2	2.09	2.02	2.17	958.5	920.4	996.6
Occupation: skill-based categories											
Professional†	146,000	5,479	834.9	802.0	869.1	1.00	...	...	0.0	...	...
Managerial	159,000	7,094	930.4	893.6	968.6	1.11	1.05	1.18	95.5	45.2	145.8
Skilled/Technical/Supervisory	391,600	20,386	979.4	959.7	999.5	1.17	1.12	1.23	144.5	105.5	183.5
Semi-skilled	303,400	16,028	1,086.6	1,057.1	1,117.0	1.30	1.24	1.37	251.7	206.8	296.7
Unskilled	115,500	8,010	1,141.1	1,099.8	1,183.9	1.37	1.29	1.44	306.2	252.5	359.9
No occupation	243,000	96,555	1,836.2	1,813.4	1,859.2	2.20	2.11	2.29	1,001.3	960.7	1,041.9
Income adequacy quintile											
Quintile 5 - richest†	309,900	23,638	980.8	966.9	994.9	1.00	...	...	0.0	...	...
Quintile 4	302,600	24,326	1,099.5	1,084.5	1,114.7	1.12	1.10	1.14	118.7	98.0	139.3
Quintile 3	287,800	28,476	1,183.5	1,169.4	1,197.8	1.21	1.18	1.23	202.7	182.7	222.6
Quintile 2	260,800	41,273	1,334.3	1,321.0	1,347.7	1.36	1.34	1.38	353.5	334.1	372.8
Quintile 1 - poorest	197,300	35,839	1,650.2	1,633.0	1,667.7	1.68	1.65	1.71	669.4	647.1	691.7
Visible minority status											
Not visible minority†	1,257,200	148,660	1,251.9	1,245.5	1,258.4	1.00	...	...	0.0	...	...
Black	16,900	873	975.7	902.7	1,054.5	0.78	0.72	0.84	-276.3	-352.4	-200.2
Southwest Asian or Arab	12,700	659	895.9	825.2	972.6	0.72	0.66	0.78	-356.1	-430.0	-282.2
South Asian	21,800	872	720.8	665.1	781.2	0.58	0.53	0.62	-531.1	-589.5	-472.8
East Asian	33,000	1,897	791.9	755.1	830.4	0.63	0.60	0.66	-460.1	-498.3	-421.9
Southeast Asian or Pacific Islander	11,000	435	686.2	619.8	759.7	0.55	0.49	0.61	-565.8	-635.9	-495.6
Latin American	4,400	91	481.8	367.8	631.1	0.38	0.29	0.50	-770.1	-900.3	-639.9
Multiple visible minorities	1,500	65	785.0	565.7	1,089.2	0.63	0.45	0.87	-467.0	-724.1	-209.8
Aboriginal origins											
No Aboriginal origins†	1,307,800	149,335	566.7	563.5	570.0	1.00	...	...	0.0	...	...
Any Aboriginal origins	50,600	4,217	797.7	774.0	822.2	1.41	1.37	1.45	231.0	206.7	255.3
Registered Indian status											
Not Registered Indian†	1,333,800	151,175	569.6	566.3	572.8	1.00	...	...	0.0	...	...
Registered Indian	24,600	2,377	886.5	851.5	923.1	1.56	1.49	1.62	317.0	281.0	352.9
Place of birth											
Same province as residence†	860,300	95,514	1,322.1	1,313.5	1,330.7	1.00	...	...	0.0	...	...
Different province	207,400	24,316	1,238.8	1,222.9	1,254.9	0.94	0.92	0.95	-83.3	-101.5	-65.1
Foreign	290,700	33,722	1,008.7	997.9	1,019.7	0.76	0.75	0.77	-313.4	-327.2	-299.5
Year of immigration											
Non-immigrant†	1,070,700	120,185	1,304.6	1,297.0	1,312.1	1.00	...	...	0.0	...	...
Before 1971	160,900	27,762	1,054.4	1,041.1	1,068.0	0.81	0.80	0.82	-250.1	-265.6	-234.7
1971 to 1980	63,200	3,429	914.1	881.3	948.0	0.70	0.68	0.73	-390.5	-424.7	-356.3
1981 to 1985	21,500	1,046	785.8	736.8	837.9	0.60	0.56	0.64	-518.8	-569.9	-467.7
1986 to 1991	34,600	873	651.5	597.7	710.2	0.50	0.46	0.54	-653.0	-709.7	-596.3
Non-permanent resident	7,400	257	982.7	855.5	1,128.8	0.75	0.66	0.87	-321.9	-458.3	-185.5

Table 4
Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized men aged 25 or older at baseline, Canada, 1991 to 2001 (continued)

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Residence 1 year before											
Same address†	1,163,500	139,671	1,215.1	1,208.7	1,221.6	1.00	...	...	0.0	...	...
Different address in same province	154,400	9,097	1,358.1	1,327.7	1,389.2	1.12	1.09	1.14	143.0	111.6	174.5
Different province	12,900	561	1,111.0	1,009.2	1,223.2	0.91	0.83	1.01	-104.1	-211.1	3.0
Foreign	7,400	184	620.4	516.0	745.9	0.51	0.42	0.61	-594.7	-709.2	-480.2
Not applicable	20,100	4,039	1,786.8	1,731.1	1,844.4	1.47	1.42	1.52	571.7	514.7	628.7
Marital status											
Legally married†	982,900	110,696	1,135.6	1,128.7	1,142.6	1.00	...	...	0.0	...	...
Common-law	93,900	4,629	1,352.7	1,298.4	1,409.3	1.19	1.14	1.24	217.1	161.2	272.9
Widowed	27,400	14,045	1,670.3	1,575.9	1,770.2	1.47	1.39	1.56	534.6	437.3	632.0
Separated	26,200	3,592	1,622.6	1,568.1	1,679.1	1.43	1.38	1.48	487.0	431.1	542.9
Divorced	45,800	6,452	1,612.2	1,566.6	1,659.0	1.42	1.38	1.46	476.5	429.8	523.2
Never married	182,200	14,138	1,620.0	1,591.9	1,648.7	1.43	1.40	1.45	484.4	455.2	513.7
Living arrangements											
With relatives†	1,179,500	123,110	1,169.8	1,163.1	1,176.5	1.00	...	...	0.0	...	...
With non-relatives	40,700	4,012	1,657.4	1,604.9	1,711.6	1.42	1.37	1.46	487.6	433.9	541.4
Alone	119,300	22,434	1,629.5	1,607.8	1,651.5	1.39	1.37	1.41	459.7	436.9	482.6
Not applicable	18,900	3,996	1,832.8	1,774.9	1,892.6	1.57	1.52	1.62	663.1	603.8	722.3
Mother tongue											
English†	776,100	87,637	1,258.1	1,249.7	1,266.5	1.00	...	...	0.0	...	...
French	335,400	38,269	1,350.4	1,336.5	1,364.5	1.07	1.06	1.09	92.3	76.0	108.7
English and French	4,200	653	1,421.0	1,314.1	1,536.7	1.13	1.04	1.22	163.0	51.5	274.4
Neither English nor French	242,600	26,993	1,020.8	1,008.5	1,033.3	0.81	0.80	0.82	-237.2	-252.2	-222.3
Knowledge of official languages											
English only†	921,600	106,013	1,211.7	1,204.4	1,219.1	1.00	...	...	0.0	...	...
French only	170,000	21,275	1,396.2	1,377.2	1,415.5	1.15	1.14	1.17	184.5	164.0	205.0
Both English and French	253,000	23,823	1,210.0	1,193.9	1,226.3	1.00	0.98	1.01	-1.7	-19.5	16.1
Neither English nor French	13,800	2,441	976.1	934.8	1,019.1	0.81	0.77	0.84	-235.7	-278.4	-192.9
Community size											
1 million or more†	411,300	42,962	1,171.9	1,160.7	1,183.3	1.00	...	...	0.0	...	...
500,000 to 999,999	216,700	21,783	1,208.0	1,191.7	1,224.6	1.03	1.01	1.05	36.1	16.2	56.1
100,000 to 499,999	205,200	24,093	1,240.2	1,224.5	1,256.2	1.06	1.04	1.08	68.3	48.9	87.8
10,000 to 99,999	190,000	23,218	1,301.5	1,284.7	1,318.6	1.11	1.09	1.13	129.6	109.3	150.0
Less than 10,000 (rural and small town)	335,200	41,496	1,263.5	1,251.4	1,275.9	1.08	1.06	1.09	91.6	75.0	108.3
Metropolitan influence zone											
CMA or CA†	1,027,900	112,441	1,218.1	1,210.9	1,225.3	1.00	...	...	0.0	...	...
Rural and small town											
Strong metropolitan influence	74,100	8,604	1,234.4	1,208.0	1,261.2	1.01	0.99	1.04	16.3	-11.3	43.8
Moderate metropolitan influence	118,500	15,950	1,269.6	1,249.9	1,289.6	1.04	1.02	1.06	51.5	30.3	72.6
Weak metropolitan influence	116,200	13,845	1,264.0	1,243.1	1,285.4	1.04	1.02	1.06	45.9	23.6	68.3
No metropolitan influence	21,700	2,712	1,352.9	1,302.8	1,405.0	1.11	1.07	1.15	134.9	83.3	186.4
Activity limitation											
No activity limitation†	1,204,900	102,474	1,029.8	1,023.3	1,036.3	1.00	...	...	0.0	...	...
Any activity limitation	145,700	49,760	2,219.7	2,197.6	2,241.9	2.16	2.13	2.18	1,189.9	1,166.8	1,213.0
Not applicable	6,800	1,318	1,699.9	1,608.7	1,796.3	1.65	1.56	1.74	670.1	576.2	764.1

† reference category
... not applicable
Note: Reference population (person-years at risk) was taken from the total cohort age distribution for all variables except Aboriginal variables, for which the Aboriginal age distribution was used.
Source: Census mortality follow-up study, 1991 to 2001.

Income adequacy

Men and women in the richest income adequacy quintile had the lowest ASMRs. RRs rose in each successively poorer quintile, but the change was greatest between quintiles 1 and 2.

As shown in the last panel of Appendix Table A, RRs varied by age group within each income adequacy quintile. For each sex and all age groups except the oldest (men) or the two oldest (women), RRs rose in each successively poorer income quintile. However, the greatest increase was between the poorest and next-poorest quintiles. RRs peaked among people aged 45 to 54 at baseline in the poorest income quintile, at nearly 2.5 for men and 2.3 for women.

Table 5
Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized women aged 25 or older at baseline, Canada, 1991 to 2001

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Education											
University degree†	161,100	4,656	549.2	532.7	566.2	1.00	...	...	0.0	...	...
Postsecondary diploma	253,100	11,292	602.6	591.4	614.1	1.10	1.06	1.14	53.4	33.2	73.6
Secondary graduation	484,000	26,517	666.5	658.5	674.6	1.21	1.17	1.25	117.3	98.7	135.9
Less than secondary graduation	478,600	64,803	781.3	774.8	787.8	1.42	1.38	1.47	232.0	214.1	250.0
Occupation: Boyd-NP socioeconomic quintile											
Quintile 5 - highest†	151,500	2,566	534.0	489.5	582.5	1.00	...	...	0.0	...	...
Quintile 4	186,900	3,691	586.7	554.5	620.8	1.10	0.99	1.22	52.8	-4.3	109.8
Quintile 3	221,200	5,254	583.8	560.3	608.3	1.09	0.99	1.20	49.9	-2.4	102.2
Quintile 2	169,200	4,545	606.3	578.2	635.7	1.14	1.03	1.25	72.3	17.7	126.9
Quintile 1 - lowest	218,700	6,894	620.4	598.7	642.8	1.16	1.06	1.28	86.4	35.0	137.8
No occupation	429,300	84,318	823.7	816.2	831.3	1.54	1.41	1.68	289.7	242.7	336.8
Occupation: skill-based categories											
Professional†	160,300	2,697	484.9	450.5	521.8	1.00	...	...	0.0	...	...
Managerial	65,800	1,486	590.2	535.9	650.0	1.22	1.08	1.37	105.3	38.1	172.5
Skilled/Technical/Supervisory	260,100	6,689	598.5	578.7	619.0	1.23	1.14	1.34	113.7	72.8	154.6
Semi-skilled	360,600	8,848	601.6	579.8	624.1	1.24	1.14	1.35	116.7	74.8	158.7
Unskilled	100,600	3,230	649.9	614.2	687.7	1.34	1.22	1.47	165.1	113.9	216.2
No occupation	429,300	84,318	823.7	816.2	831.3	1.70	1.58	1.83	338.9	302.4	375.3
Income adequacy quintile											
Quintile 5 - richest†	277,500	12,955	592.3	581.7	603.1	1.00	...	...	0.0	...	...
Quintile 4	278,200	13,612	633.1	622.3	644.0	1.07	1.04	1.10	40.8	25.5	56.0
Quintile 3	277,700	16,182	666.5	656.3	677.0	1.13	1.10	1.15	74.3	59.4	89.1
Quintile 2	270,300	25,129	722.0	712.7	731.4	1.22	1.19	1.25	129.7	115.5	143.8
Quintile 1 - poorest	273,000	39,390	884.3	874.3	894.4	1.49	1.46	1.53	292.0	277.4	306.6
Visible minority											
Not visible minority†	1,272,800	103,973	713.3	708.9	717.7	1.00	...	...	0.0	...	...
Black	20,000	729	555.2	514.0	599.7	0.78	0.72	0.84	-158.1	-201.1	-115.0
Southwest Asian or Arab	9,600	356	574.8	513.5	643.3	0.81	0.72	0.90	-138.5	-203.4	-73.6
South Asian	19,000	464	573.2	514.3	638.8	0.80	0.72	0.90	-140.1	-202.4	-77.8
East Asian	34,000	1,266	471.7	446.0	498.8	0.66	0.63	0.70	-241.6	-268.3	-214.9
Southeast Asian or Pacific Islander	14,900	359	440.7	392.7	494.5	0.62	0.55	0.69	-272.6	-323.6	-221.6
Latin American	4,800	78	458.7	353.7	594.9	0.64	0.50	0.83	-254.6	-373.9	-135.2
Multiple visible minorities	1,700	43	498.5	334.1	743.6	0.70	0.47	1.04	-214.8	-414.2	-15.4
Aboriginal origins											
No Aboriginal origins†	1,316,500	103,890	318.9	316.5	321.3	1.00	...	...	0.0	...	...
Any Aboriginal origins	60,200	3,378	559.8	541.2	579.0	1.76	1.70	1.82	240.9	221.8	259.9
Registered Indian status											
Not Registered Indian†	1,344,700	105,139	321.2	318.8	323.5	1.00	...	...	0.0	...	...
Registered Indian	32,100	2,129	623.7	597.7	650.8	1.94	1.86	2.03	302.5	275.9	329.2
Place of birth											
Same province as residence†	883,400	66,810	734.2	728.6	739.8	1.00	...	...	0.0	...	...
Different province	210,600	17,131	717.3	706.6	728.2	0.98	0.96	0.99	-16.9	-29.0	-4.7
Foreign	282,800	23,327	611.9	603.9	620.1	0.83	0.82	0.85	-122.3	-132.1	-112.4
Year of immigration											
Non-immigrant†	1,096,800	84,181	730.8	725.8	735.8	1.00	...	...	0.0	...	...
Before 1971	149,500	18,825	637.2	627.0	647.5	0.87	0.86	0.89	-93.6	-105.0	-82.3
1971 to 1980	65,300	2,495	547.7	525.8	570.5	0.75	0.72	0.78	-183.1	-206.0	-160.2
1981 to 1985	23,400	799	526.1	490.1	564.8	0.72	0.67	0.77	-204.7	-242.3	-167.0
1986 to 1991	35,000	665	454.4	417.8	494.1	0.62	0.57	0.68	-276.4	-314.8	-238.0
Non-permanent resident	6,800	303	721.4	633.5	821.7	0.99	0.87	1.12	-9.4	-103.3	84.6

Table 5
Age-standardized mortality rates (ASMR) per 100,000 person-years at risk, showing rate ratios (RR) and rate differences (RD), by selected socio-economic characteristics, non-institutionalized women aged 25 or older at baseline, Canada, 1991 to 2001 (continued)

Characteristic	Baseline population	Deaths	ASMR	95 % confidence interval from	to	RR	95 % confidence interval from	to	RD	95 % confidence interval from	to
Residence 1 year before											
Same address†	1,179,000	94,654	698.7	694.3	703.2	1.00	...	...	0.0	...	...
Different address in same province	155,700	6,452	779.6	760.2	799.6	1.12	1.09	1.15	80.9	60.7	101.1
Different province	12,500	412	680.4	613.4	754.8	0.97	0.88	1.08	-18.3	-89.0	52.4
Foreign	7,400	125	428.7	349.8	525.4	0.61	0.50	0.75	-270.0	-357.3	-182.7
Not applicable	22,100	5,625	785.4	750.6	821.9	1.12	1.07	1.18	86.7	50.8	122.7
Marital status											
Legally married†	864,800	37,176	610.4	603.3	617.5	1.00	...	...	0.0	...	...
Common-law	88,900	2,012	822.3	750.1	901.5	1.35	1.23	1.48	212.0	136.1	287.9
Widowed	144,800	47,074	842.5	811.4	874.7	1.38	1.33	1.44	232.1	199.7	264.6
Separated	39,000	2,362	798.4	763.7	834.7	1.31	1.25	1.37	188.0	151.9	224.2
Divorced	79,800	5,461	830.1	804.0	857.0	1.36	1.31	1.41	219.7	192.3	247.1
Never married	159,500	13,183	808.4	793.1	823.9	1.32	1.30	1.35	198.0	181.1	215.0
Living arrangements											
Living with relatives†	1,136,800	57,804	674.6	669.0	680.3	1.00	...	...	0.0	...	...
Living with non-relatives	32,000	2,394	874.1	839.2	910.4	1.30	1.24	1.35	199.5	163.5	235.5
Living alone	187,200	41,481	817.7	806.7	828.8	1.21	1.19	1.23	143.1	130.7	155.5
Not applicable	20,700	5,589	808.6	769.4	849.8	1.20	1.14	1.26	134.0	93.4	174.6
Mother tongue											
English†	794,100	64,432	748.1	742.3	753.9	1.00	...	...	0.0	...	...
French	345,900	25,727	666.3	658.1	674.6	0.89	0.88	0.90	-81.8	-91.9	-71.7
English and French (rare)	4,400	448	783.0	711.4	861.8	1.05	0.95	1.15	34.9	-40.4	110.2
Neither English nor French	232,400	16,661	616.5	607.1	626.0	0.82	0.81	0.84	-131.6	-142.7	-120.5
Knowledge of official languages											
English only†	925,200	75,326	728.6	723.4	733.8	1.00	...	...	0.0	...	...
French only	209,100	17,175	675.0	664.7	685.4	0.93	0.91	0.94	-53.6	-65.2	-42.0
Both English and French	221,700	12,139	628.4	617.2	639.7	0.86	0.85	0.88	-100.2	-112.6	-87.8
Neither English nor French	20,800	2,628	601.5	576.1	628.1	0.83	0.79	0.86	-127.1	-153.6	-100.5
Community size											
1 million or more†	433,000	32,050	662.1	654.9	669.5	1.00	...	...	0.0	...	...
500,000 to 999,999	225,200	16,544	687.5	677.0	698.1	1.04	1.02	1.06	25.4	12.5	38.2
100,000 to 499,999	212,100	18,096	733.1	722.3	744.0	1.11	1.09	1.13	70.9	57.9	84.0
10,000 to 99,999	191,900	15,906	727.0	715.6	738.5	1.10	1.08	1.12	64.8	51.3	78.4
Less than 10,000 (rural and small town)	314,600	24,672	734.9	725.7	744.2	1.11	1.09	1.13	72.7	61.0	84.5
Metropolitan influence zone											
CMA or CA†	1,066,500	82,827	693.6	688.8	698.3	1.00	...	...	0.0	...	...
Rural and small town											
Strong metropolitan influence	67,800	4,686	695.2	675.6	715.4	1.00	0.97	1.03	1.6	-18.9	22.1
Moderate metropolitan influence	111,700	9,686	722.6	708.1	737.3	1.04	1.02	1.06	29.0	13.7	44.4
Weak metropolitan influence	109,800	8,468	756.8	740.7	773.3	1.09	1.07	1.12	63.3	46.3	80.2
No metropolitan influence	21,000	1,601	844.5	803.8	887.3	1.22	1.16	1.28	151.0	108.9	193.0
Activity limitation											
No activity limitation†	1,228,600	65,852	577.3	572.9	581.8	1.00	...	...	0.0	...	...
Any activity limitation	141,100	39,745	1,330.1	1,312.9	1,347.5	2.30	2.27	2.34	752.8	734.9	770.6
Not applicable	7,100	1,671	989.5	926.4	1,056.9	1.71	1.60	1.83	412.2	346.8	477.6

† reference category
... not applicable
Note: Reference population (person-years at risk) was taken from the total cohort age distribution for all variables except Aboriginal variables, for which the Aboriginal age distribution was used.
Source: Census mortality follow-up study, 1991 to 2001.

Visible minorities

All visible minority groups had lower ASMRs, compared with Canadians who were not part of any visible minority. A large part of this difference could be explained by the "healthy immigrant" effect (as evident in the mortality hazard ratios for visible minorities compiled separately for Canadian-born and foreign-born, data not shown). For the Canadian-born, visible minority status was significantly protective only for ethnic Chinese, both men and women.

Aboriginal origins

Persons with any Aboriginal origins (First Nations, Métis, Inuit) had higher ASMRs (standardized to the Aboriginal population structure) than did persons with no Aboriginal ancestry. RRs were greater for Aboriginal women (1.76) than men (1.41). Mortality rates were highest among Registered Indians (a subset of First Nations), with RRs of 1.56 for men and 1.94 for women, compared with all other residents of Canada.

Immigration and mobility

Compared with the Canadian-born population, mortality rates were substantially lower among immigrants, particularly recent immigrants. However, immigrants' mortality advantage lessened as the number of years since immigration increased.

Mortality rates did not vary greatly by mobility (excluding those who had lived in a foreign country the year before the census), except for people who had lived at a different address in the same province the year before to the census, who had slightly higher mortality rates than did non-movers.

Marital status and living arrangements

Currently married men and women had lower mortality rates than did unmarried or previously married people. The results also revealed somewhat higher mortality for people in common-law unions, compared with those who were legally married.

Language

Men whose mother tongue was French had a somewhat higher mortality rate than did men whose mother tongue was English; the reverse was true among women. However, regardless of sex, Allophones (neither English nor French) had considerably lower mortality rates than other Canadians—due, in large part, to the "healthy immigrant" effect.

Results by knowledge of official languages (reported ability to converse in English or French, even if not fluently) revealed that, compared with the "English only" reference group, men able to converse only in French had somewhat higher mortality rates, while women able to converse only in French had somewhat lower mortality rates. For people able to converse in both English and French, the mortality rate for men was the same as that of the reference group, while the rate for women was somewhat lower. Men unable to converse in either English or French had considerably lower mortality rates, and women, somewhat lower rates (about the same as for bilingual females), compared with the "English-only" reference group.

Community size and metropolitan influence zone

Mortality rates varied by community size and metropolitan influence zone. Rates were lowest in metropolitan areas with a population of one million or more (Montreal, Toronto and Vancouver CMAs), and next lowest in metropolitan areas with a population of 500,000 to less than one million. Rates were somewhat higher in smaller urban areas and rural areas. However, in rural and small-town areas with strong metropolitan influence (30% to 49% of the workforce commuting to any CMA or CA), mortality rates were not significantly higher than those in all CMAs and CAs. By contrast, rates were substantially elevated in areas where the metropolitan influence was weak, particularly in zones with no metropolitan influence (none of the workforce commuting to a CMA or CA).

Activity limitations

People who reported an activity limitation had higher mortality rates than those who did not. Mortality rates during the follow-up period among people with an activity limitation were more than double the rates among people without an activity limitation.

Why is this study important?

- An important first step to monitor progress toward reducing or eliminating socio-economic inequalities in health is to determine the distribution of mortality rates across various groups.
- Until now, no nationally representative Canadian population-based cohort studies have examined mortality by socio-economic status.

What else is known on this topic?

- Results from other countries have consistently shown lower education levels and lower-status occupational categories (and the economically inactive) to have the highest mortality rates.

What does this study add?

- These results provide important baseline information on the nature and extent of socio-economic inequalities in mortality in Canada.
- A much greater disparity was revealed by individual and family income compared with neighbourhood income, especially for women.

Discussion

In this analysis, mortality rates were much lower among people of higher socio-economic status, regardless of whether socio-economic status was determined by education, occupation or income. The findings reveal a clear stair-stepped gradient in mortality, with

wider steps nearer the bottom as compared with the top of the socio-economic hierarchy.

The lowest mortality rates were among the university-educated, the employed, those in professional and managerial occupations, and those in the top income brackets. The highest mortality rates were among people with less than secondary graduation, those who were unemployed or not in the labour force, those in unskilled jobs, and those in the lowest income brackets.

Mortality rates also varied by ascribed characteristics such as ethnic origin, Aboriginal ancestry and mother tongue, and by achieved characteristics such as knowledge of official languages, mobility and marital status. Mortality rates also differed by the presence of activity limitations.

The census mortality follow-up study data provide a new set of reference mortality rates for occupational mortality studies, based on people with an occupation, or those gainfully employed at baseline. Previously, the use of reference mortality rates for the total population (including many people not in the labour force) may sometimes have prevented detection of moderately elevated mortality rates among workers.

Compared with life tables by neighbourhood income quintiles for urban Canada[71] (unpublished annexes available on request), life tables based on individual and family income quintiles revealed a 2.0-year greater inter-quintile disparity in remaining life expectancy at age 25 for men (6.8 years in this cohort versus 4.8 years in the neighbourhood data), and a 2.9-year greater disparity for women (4.3 versus 1.4 years). In terms of the expected probability of survival from ages 25 to 75, this analysis revealed a 6.5 percentage-point greater inter-quintile disparity for men (21.7 versus 15.2) and a 5.7 percentage-point greater disparity for women (12.3 versus 6.6). By either measure, a much greater inter-quintile disparity was revealed by individual and family income compared to neighbourhood income, especially for women.

Although international comparisons were not included in these initial results, it should now be possible to make such comparisons with the findings of census mortality follow-up studies in other countries.

Strengths and limitations

The study was limited to people aged 25 or older at the time of the 1991 census, and it excluded institutional residents, non-tax-filers and persons missed by the census. Thus, the cohort had somewhat lower mortality rates than the Canadian population, especially at older ages.

Because of the reasonably high "response" rate (80%) and the large number of people followed (about 2.7 million, including 260,000 deaths), the study was broadly representative of most groups in the Canadian population. However, some groups were over- or under-represented (notably, Aboriginal people) in the sample that could be followed for mortality. Use of more comprehensive nominal list files as sources of names for subsequent encryption might have improved the probabilistic matching rate from census to the name file. Nevertheless, for those records that were matched, the accuracy of the match from census to the name file was very high (99%).

All of the socio-economic variables were only known at baseline (1991), although any achieved characteristic may change over time. For most of the census variables except age, occupation and language, imputed values could not be distinguished from non-imputed values, but records based on "hot deck" imputation were not included. Information on behavioural risk factors such as smoking and physical activity was not available from the census.

After matching to the Canadian Mortality Data Base, a single underlying cause of death was available for people determined to have died during the study period, but contributing causes of death were not available.

All comparisons were age-standardized or adjusted for age.

Implications for future research

The results of the 1991-to-2001 census mortality follow-up study can help to inform future research that examines socio-economic differences in health outcomes and health care use in Canada. The results provide detailed baseline data on the nature and extent of socio-economic inequalities in mortality, which is the most fundamental health outcome and the essential starting point for a true understanding of the impact of socio-economic disparities on population health.

Because of the rich detail of the Canadian census with respect to socio-economic characteristics, the findings of the census mortality follow-up study are pertinent to the consideration of various policy alternatives. When clear relationships have been established connecting mortality not only to income (and sources of income), but also to education, employment and housing (among other variables), the evidence base for informed policy decisions is widened considerably. This study thus broadens the evidence base for informed decisions.

These findings provide fundamentally important baseline data on the nature and extent of socio-economic inequalities in mortality in Canada at the end of the 20th century. However, this report is only an initial profile of the results, examining the variables one by one. Future analyses should determine how the various dimensions are connected—for example, to what extent are inequalities in mortality across income brackets (or Aboriginal or visible minority groups) explained by inequalities in education and occupation, and which causes of death contribute most to the disparities? ■

Acknowledgements

We are grateful to the former Occupational and Environmental Health Research Section of the Health Statistics Division for carrying out the record linkages, thanks to the work of Bryan LaFrance, Lana Marjama, Peggy Cyr, Pierre Lalonde, Marie Beaudet, Christel LePetit, and Martha Fair. We thank Evelyne Perkins of the Record Linkage Resource Centre (for linkage software assistance), Paul Hartung of the Data Access and Retrieval System (for census long-form data), and the following members of the Health Analysis and Measurement Group (now Health Information and Research Division): François Gendron, Julie Bernier, Jean-Marie Berthelot, and Jillian Oderkirk. Michael Wolfson, Assistant Chief Statistician, provided moral and material support for this work since its inception. This study benefited from earlier work on the design of census-mortality linkages by Howard Newcombe and Martha Smith, Elizabeth Coppock, Loraine Marrett, Ruhee Chaudhry, and Kristan Aronson. We are especially grateful to the Canadian Population Health Initiative, which funded the creation of the census mortality follow-up study, for their patience and perseverance in the face of numerous delays. The Canadian Institutes of Health Research, the Ontario Workplace Safety and Insurance Board, and the Institut national de santé publique du Québec contributed to other analyses of the linked data. Finally, we would like to acknowledge Canada's provincial and territorial registrars of vital statistics, who furnish the death data for the Canadian Mortality Data Base.

References

1. First Ministers of Canada. *2003 First Ministers' Accord on Health Care Renewal*. Ottawa: Government of Canada, 2003. Available at http://www.hc-sc.gc.ca/hcs-sss/delivery-prestation/fptcollab/2003accord/index_e.html. Accessed February 19, 2008.
2. Muntaner C, Sorlie P, O'Campo P, et al. Occupational hierarchy, economic sector, and mortality from cardiovascular disease among men and women. Findings from the National Longitudinal Mortality Study. *Annals of Epidemiology* 2001; 11(3): 194-201.
3. Elo IR, Preston SH. Educational differentials in mortality: United States, 1979-85. *Social Science and Medicine* 1996; 42(1): 47-57.
4. Sorlie PD, Backlund E, Keller JB. U.S. mortality by economic, demographic and social characteristics: The National Longitudinal Mortality Study. *American Journal of Public Health* 1995; 85: 949-56.
5. Rogot E, Sorlie PD, Johnson NJ, et al. *A mortality study of one million persons by demographic, social, and economic factors: 1979-1981 follow-up*. First data book (NIH Publ No. 88-2896) Washington, DC: US DHHS, Public Health Service, 1988.
6. Johnson B, Blackwell L. Review of methods for estimating life expectancy by social class using the ONS Longitudinal Study. *Health Statistics Quarterly* 2007; Autumn(35): 28-36.
7. Sloggett A, Young H, Grundy E. The association of cancer survival with four socioeconomic indicators: a longitudinal study of the older population of England and Wales 1981-2000. *BMC Cancer* 2007; 7: 20.
8. Goldblatt P. Mortality by social class, 1971-85. *Population Trends* (HMSO) 1989; 56: 6-15
9. Fox AJ, Goldblatt PO. *Longitudinal Study. Socio-demographic Mortality Differentials* (Series LS no. 1). London: HMSO, 1982.
10. Fischbacher CM, Bhopal R, Povey C, et al. Record linked retrospective cohort study of 4.6 million people exploring ethnic variations in disease: myocardial infarction in South Asians. *BMC Public Health* 2007; 5(7): 142.
11. Menvielle G, Chastang JF, Luce D, et al. Évolution temporelle des inégalités sociales de mortalité en France entre 1968 et 1996. Étude en fonction du niveau d'études par cause de décès. *Revue d'épidemiologie et de santé publique* 2007; 55(2): 97-105.
12. Leclerc A, Chastang JF, Menvielle G, Luce D. Socioeconomic inequalities in premature mortality in France: have they widened in recent decades? *Social Science and Medicine* 2006; 62(8): 2035-45.
13. Cambois E. Careers and mortality in France: evidence on how far occupational mobility predicts differentiated risks. *Social Science and Medicine* 2004; 58(12): 2545-58.
14. Couet C. *L'échantillon démographique permanent de l'Insee. Courrier des statistiques* 2006; 117-119: 5-14. Available at http://www.insee.fr/fr/ffc/docs_ffc/cs1176.pdf. Accessed July 10, 2008.
15. Leclerc A, Lert F, Goldberg M. Les inégalités sociales devant la mort en Grande-Bretagne et en France. *Social Science and Medicine* 1994; 19(5): 479-87.
16. Desplanques G. *La mortalité des adultes : résultats de 2 études longitudinales (période 1955-1980)*. Paris, INSEE, 1984.
17. Martikainen P, Valkonen T. Bias related to the exclusion of the economically inactive in studies on social class differences in mortality. *International Journal of Epidemiology* 1999; 28: 899-904.
18. Valkonen T. Problems in the measurement and international comparisons of socio-economic differences in mortality. *Social Science and Medicine* 1993; 36(4): 409-18.
19. Valkonen T, Martelin T, Rimpela A. *Socio-economic Mortality Differences in Finland 1971-85*. Population Series. Helsinki: Statistics Finland, 1990.
20. Vaupel J, Gjonca E. *Socioeconomic Determinants of Longevity in Denmark, England and Wales and the USA—A Comparative Study*. Rostock, Germany: Max Planck Institute for Demographic Research, 2000.

21. Andersen O. *Dodelighed ag Erhverv 1970-1980*. Copenhagen: Statistics Denmark, 1985.

22. Bronfmann-Hansen H, Baadsgaard M. Increase in social inequality in health expectancy in Denmark. *Scandinavian Journal of Public Health* 2008; 36(1): 44-51.

23. Diderichsen F, Hallqvist J. Trends in occupational mortality among middle-aged men in Sweden 1961-1990. *International Journal of Epidemiology* 1997; 26(4): 782-7.

24. Olausson PO. Mortality among the elderly in Sweden by social class. *Social Science and Medicine* 1991;32(4): 437-40.

25. Vågerö D, Lundberg O. Health inequalities in Britain and Sweden. *The Lancet* 1989; ii: 35-6.

26. Naess O, Claussen B, Thelle DS, Smith GD. Four indicators of socioeconomic position: relative ranking across causes of death. *Scandinavian Journal of Public Health* 2005; 33(3): 215-21.

27. Dahl E. High mortality in lower salaried Norwegian men: the healthy worker effect? *Journal of Epidemiology and Community Health*. 1993; 47(3): 192-4.

28. Dahl E, Kjaersgaard P. Social mobility and inequality in mortality. An assessment of the health selection hypothesis. *European Journal of Public Health* 1993; 3: 124-32.

29. Valkonen T. Adult mortality and level of education: a comparison of six countries. In Fox J, ed.: *Health Inequalities in European Countries*. Alsershot, England: Gower, 1989: 142-72.

30. Pagnanelli F. Une synthèse des informations sur les différences de mortalité en Italie selon certain facteurs socio-économiques. In: *Proceedings of the Fifth Meeting of the UNDP/WHO/CICRED Network on Socio-Economic Differential Mortality in Industrialized Countries*. Paris: Committee for International Cooperation in National Research on Demography (CICRED), 1991.

31. Borrell C, Azlor E, Rodríguez-Sanz M, et al. Trends in socioeconomic mortality inequalities in a southern European urban setting at the turn of the 21st century. *Journal of Epidemiology and Community Health*. 2008; 62(3): 258-66.

32. Bopp M, Spoerri A, Zwahlen M, et al. Cohort profile: The Swiss National Cohort – a longitudinal study of 6.8 million people. *International Journal of Epidemiology* May 7, 2008 [Epub ahead of print]. Available at doi:10.1093/ije/dgn042.

33. Bopp M, Minder CE. Mortality by education in German speaking Switzerland, 1990-1997: results from the Swiss National Cohort. *International Journal of Epidemiology* 2003, 32, 346-354. Available at http://ije.oxfordjournals.org/cgi/reprint/32/3/346. Accessed February 19, 2008.

34. Spoerri A, Zwahlen M, Egger M, et al. Educational inequalities in life expectancy in German speaking part of Switzerland 1990-1997: Swiss National Cohort. *Swiss Medical Weekly* 2006; 136: 145-8. Available at http://www.smw.ch/dfe/set_archiv.asp?target=2006/09/smw-11328. Accessed February 19, 2008.

35. Van Oyen H, Bossuyt N, Deboosere P, et al. Differential inequity in health expectancy by region in Belgium. *Sozial- und Praventivmedizin* 2005; 50(5): 301-10. Erratum in: *Sozial- und Praventivmedizin* 2006; 51(1): 67.

36. Schwarz F. Causes of death contributing to educational mortality disparities in Austria. *Wiener klinische Wochenschrift* 2007; 119(9-10): 309-17.

37. Shkolnikov VM, Jasilionis D, Andreev EM, et al. Linked versus unlinked estimates of mortality and length of life by education and marital status: evidence from the first record linkage study in Lithuania. *Social Science and Medicine* 2007; 64(7): 1392-406.

38. Jaffe DH, Eisenbach Z, Neumark YD, Manor O. Effects of husbands' and wives' education on each other's mortality. *Social Science and Medicine* 2006; 62(8): 2014-23.

39. Blakely T, Tobias M, Atkinson J. Inequalities in mortality during and after restructuring of the New Zealand economy: repeated cohort studies. *British Medical Journal* 2008; 336(7640): 371-5.

40. Mackenbach JP, Bos V, Andersen O, et al. Widening socioeconomic inequalities in mortality in six Western European countries. *International Journal of Epidemiology* 2003; 32(5): 830-7.

41. Strand BH, Kunst A, Huisman M, et al. The reversed social gradient: higher breast cancer mortality in the higher educated compared to lower educated. A comparison of 11 European populations during the 1990s. *European Journal of Cancer* 2007; 43(7): 1200-7.

42. Lagerlund M, Bellocco R, Karlsson P, et al. Socio-economic factors and breast cancer survival—a population-based cohort study (Sweden). *Cancer Causes Control* 2005; 16(4): 419-30.

43. Mackenbach JP, Huisman M, Andersen O, et al. Inequalities in lung cancer mortality by the educational level in 10 European populations. *European Journal of Cancer* 2004; 40(1): 126-35.

44. Menvielle G, Kunst AE, Stirbu I, et al. Socioeconomic inequalities in alcohol related cancer mortality among men: to what extent do they differ between Western European populations? *International Journal of Cancer* 2007; 121(3): 649-55.

45. Hemström O. Alcohol-related deaths contribute to socioeconomic differentials in mortality in Sweden. *European Journal of Public Health* 2002; 12(4): 254-62.

46. Avendaño M, Kunst AE, Huisman M, et al. Educational level and stroke mortality: a comparison of 10 European populations during the 1990s. *Stroke* 2004; 35(2): 432-7.

47. Avendano M, Kunst AE, Huisman M, et al. Socioeconomic status and ischaemic heart disease mortality in 10 western European populations during the 1990s. *Heart* 2006; 92(4): 461-7. Available at http://heart.bmj.com/cgi/reprint/92/4/461. Accessed February 19, 2008.

48. Fawcett J, Blakely T. Cancer is overtaking cardiovascular disease as the main driver of socioeconomic inequalities in mortality: New Zealand (1981-99). *Journal of Epidemiology and Community Health*. 2007; 61(1): 59-66.

49. Manor O, Eisenbach Z, Friedlander Y, Kark JD. Educational differentials in mortality from cardiovascular disease among men and women: the Israel Longitudinal Mortality Study. *Annals of Epidemiology* 2004; 14(7): 453-60.

50. Huisman M, Kunst AE, Bopp M, et al. Educational inequalities in cause-specific mortality in middle-aged and older men and women in eight western European populations. *The Lancet* 2005; 365(9458): 493-500.

51. Huisman M, Kunst AE, Andersen O, et al. Socioeconomic inequalities in mortality among elderly people in 11 European populations. *Journal of Epidemiology and Community Health*. 2004; 58(6): 468-75.

52. Roos LL, Magoon J, Gupta S, et al. Socioeconomic determinants of mortality in two Canadian provinces: multilevel modelling and neighborhood context. *Social Science and Medicine* 2004; 59(7): 1435-47.

53. Aronson K, Howe G, Fair M, Carpenter M. *Occupational Surveillance in Canada: Cause-specific Mortality among Workers, 1965 to 1991* (Statistics Canada, Catalogue 84-546-XCB) Ottawa: Statistics Canada, 2000.

54. Martel L, Bélanger A. An analysis of the change in dependence-free life expectancy in Canada between 1986 and 1996. In: Bélanger A, Gilbert S, eds. *Report on the Demographic Situation in Canada 1998-1999* (Statistics Canada, Catalogue 91-209-XPE) Ottawa: Minister of Industry, 2006: 164-86 (and Erratum).

55. Chen J, Beavon D, Wilkins R. Mortality of retired public servants in Canada. *Proceedings of the Social Statistics Section, Annual Meeting of the American Statistical Association*. Chicago, 1996: 86-91

56. Wolfson MC, Rowe G, Gentleman JF, Tomiak M. Career earnings and death: a longitudinal analysis of older Canadian men. *Journal of Gerontology: Social Sciences* 1993; 49(4): 5167-79.

57. Wigle DT, Semenciw RM, Wilkins K, et al. Mortality study of Canadian male farm operators: non-Hodgkin's lymphoma mortality and agricultural practices in Saskatchewan. *Journal of the National Cancer Institute* 1990; 82(7): 575-82.

58. Wigle DT, Mao Y, Arraiz G. Mortality follow-up study: Results from the Canada Health Survey. Abstract. *Chronic Diseases in Canada* 1989; 10(4): 44-9.

59. Hirdes JP, Forbes WF. Estimates of the relative risk of mortality based on the Ontario Longitudinal Study of Aging. *Canadian Journal on Aging* 1989; 8: 222-37.

60. Havens B. *A Case Study in Sample Mortality: The Aging in Manitoba Longitudinal Study*. Paper presented to the Canadian Association on Gerontology. Halifax, October 22, 1988.

61. Johansen H, Semenciw R, Morrison H, et al. Important risk factors for death in adults: a 10-year follow-up of the Nutrition Canada Survey cohort. *Canadian Medical Association Journal* 1987; 136: 823-8.

62. Howe GR, Lindsay JP. A follow-up study of a ten-percent sample of the Canadian labour force: Cancer mortality in males, 1965-1973. *Journal of the National Cancer Institute* 1983; 70: 37-44.

63. Howe GR, Lindsay J, Miller AB. Cancer incidence and mortality in relation to occupation in 700,000 members of the Canadian labour force. *Cancer Detection and Prevention* 1980; 3: 487-97.

64. Jordan-Simpson DA, Fair ME, Poliquin C. Canadian farm operators study: methodology. *Health Reports* (Statistics Canada, Catalogue 82-003) 1990; 2(2): 141-55.

65. Statistics Canada. *Approved Record Linkages, 2003: Baseline Indicators of Mortality for Monitoring Health Disparities*. Available at http://www.statcan.ca/english/recrdlink/2003.htm#0312. Accessed February 20, 2008.

66. Fair M. Generalized Record Linkage System – Statistics Canada's record linkage software. *Austrian Journal of Statistics* 2004; 33(1&2): 37-53. Available at http://www.stat.tugraz.at/AJS/ausg041+2/041+2Fair.pdf. Accessed February 19, 2008.

67. Statistics Canada. *Coverage*. Reference Products, Technical Reports, 1991 Census of Population (Catalogue 92-341XPE) Ottawa: Minister of Industry, Science and Technology, 1994.

68. Fair ME, Carpenter M, Aylwin H. *Occupational and Environmental Health Research Projects: A Descriptive Catalogue 1978 to 2005* (Statistics Canada, Catalogue 82-581-XWE) Ottawa: Statistics Canada, 2006. Available at http://www.statcan.ca/english/freepub/82-581-XIE/82-581-XIE2006001.pdf. Accessed February 19, 2008.

69. Statistics Canada. *User's Guide to the 1991 Health and Activity Limitation Survey (HALS)* (Catalogue 82F0011GPB) Ottawa: Minister of Industry, Science and Technology, 1994.

70. Statistics Canada . *Life Tables – Canada, Provinces and Territories, 1995-1997* (Catalogue 84-537) Ottawa: Minister of Industry, 2002.

71. Wilkins R, Berthelot J-M, Ng E. Trends in mortality by neighbourhood income in urban Canada from 1971 to 1996. *Health Reports* (Statistics Canada, Catalogue 82-003) 2002; 13(Supplement): 45-71.

72. Carrière KC, Roos L. A method of comparison for standardized rates of low-incidence events. *Medical Care* 1997; 35(1): 57-69.

73. Chiang CL. *The Life Table and its Applications*. Malabar, Florida: Robert E. Krieger, 1984.

74. World Health Organization. *Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death. Ninth Revision*. Geneva: World Health Organization, 1977.

75. World Health Organization. International Statistical Classification of Diseases and Related Health Problems, Tenth Revision. Geneva: World Health Organization, 1992.

76. Boyd M. A socioeconomic scale for Canada: Measuring occupational status from the census. *Canadian Review of Sociology* 2008: 45(1): 51-91.

77. Blishen BR, Carroll WK, Moore C. The 1981 index for occupations in Canada. *Canadian Review of Sociology and Anthropology* 1987; 24(4): 465-485.

78. Statistics Canada. *1991 Census Dictionary* (Catalogue 92-301E) Ottawa: Supply and Services Canada, 1992.

79. McNiven C, Puderer H, Janes D. *Census Metropolitan Area and Census Agglomeration Influence Zones (MIZ): A Description of the Methodology*. Geography Working Paper Series No. 2000-2 (Statistics Canada, Catalogue 92F0138MPE) Ottawa: Geography Division, Statistics Canada, 2000.

80. Mustard CA, Derksen S, Berthelot JM, et al. Age-specific education and income gradients in morbidity and mortality in a Canadian province. *Social Science and Medicine* 1997; 45(3): 383-97.

Appendix

Table A
Mortality rate ratios, by sex, age group, education, occupation and income adequacy, non-institutionalized population aged 25 or older, Canada, 1991 to 2001

Category	Total	Age at baseline						
		25 to 34	35 to 44	45 to 54	55 to 64	65 to 74	75 to 84	85 or older
Baseline population								
Men (number)	1,358,400	371,900	353,700	243,000	190,500	135,700	55,300	8,200
Women (number)	1,376,800	400,500	364,700	226,600	161,700	136,400	71,600	15,300
Deaths								
Men (number)	153,552	4,481	8,122	14,804	31,674	50,359	36,877	7,235
Women (number)	107,268	2,449	5,368	8,264	14,726	29,871	34,796	11,794
Education								
Men								
University degree†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.13	1.33	1.32	1.40	1.27	1.13	1.04‡	0.91‡
Secondary graduation	1.30	1.88	1.75	1.75	1.54	1.31	1.10	0.95‡
Less than secondary graduation	1.55	2.86	2.39	2.29	1.94	1.53	1.19	1.09‡
Women								
University degree†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.10	1.24	1.29	1.18	1.22	1.11	1.05‡	0.92‡
Secondary graduation	1.21	1.54	1.46	1.39	1.40	1.24	1.11	0.97‡
Less than secondary graduation	1.42	2.42	2.06	1.78	1.75	1.44	1.19	0.99‡
Occupation								
Men								
Professional†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.11	1.04‡	1.11	1.10	1.22	1.09	1.13‡	0.99‡
Skilled/Technical/Supervisory	1.17	1.40	1.50	1.47	1.38	1.11	1.05‡	0.98‡
Semi-skilled	1.30	1.79	1.85	1.73	1.54	1.18	1.16	1.00‡
Unskilled	1.37	2.17	2.13	1.99	1.68	1.19	1.17	0.97‡
No occupation	2.20	5.85	6.15	4.69	2.58	1.62	1.35	1.37
Women								
Professional†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.22	1.01‡	1.15‡	1.21	1.20	1.32	0.97‡	2.22
Skilled/Technical/Supervisory	1.23	1.13‡	1.23	1.24	1.25	1.23	1.13‡	1.77
Semi-skilled	1.24	1.42	1.35	1.28	1.26	1.18	1.17‡	1.57
Unskilled	1.34	1.59	1.65	1.42	1.44	1.29	1.20‡	1.60
No occupation	1.70	2.58	2.42	2.40	2.01	1.67	1.22	1.77
Income adequacy quintile								
Men								
Quintile 5 - richest†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.12	1.12	1.17	1.16	1.20	1.14	1.06	1.06‡
Quintile 3	1.21	1.25	1.23	1.31	1.39	1.23	1.09	1.05‡
Quintile 2	1.36	1.51	1.44	1.59	1.60	1.42	1.16	1.12
Quintile 1 - poorest	1.68	2.34	2.40	2.45	2.18	1.61	1.29	1.13
Women								
Quintile 5 - richest†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.07	1.02‡	1.06‡	1.15	1.18	1.11	1.01‡	0.95‡
Quintile 3	1.13	1.12‡	1.20	1.30	1.29	1.14	1.04‡	0.95‡
Quintile 2	1.22	1.39	1.44	1.48	1.54	1.27	1.03‡	0.91
Quintile 1 - poorest	1.49	2.05	2.15	2.34	2.01	1.50	1.11	0.95‡

† reference category
‡ not significantly different from reference category ($p < 0.05$)
Notes: Rate ratios were calculated from age-standardized mortality rates (ASMRs) standardized to the cohort age structure of person-years at risk. The ASMRs for each 10-year age group were standardized on 5-year age groups.
Source: Census mortality follow-up study, 1991 to 2001.

Table B
Mortality hazard ratios, by sex, age group, education, occupation, income adequacy and activity limitation, non-institutionalized population aged 25 or older, Canada, 1991 to 2001

		Age at baseline						
Category	**Total**	**25 to 34**	**35 to 44**	**45 to 54**	**55 to 64**	**65 to 74**	**75 to 84**	**85 or older**
Baseline population								
Men (number)	1,358,400	371,900	353,700	243,000	190,500	135,700	55,300	8,200
Women (number)	1,376,800	400,500	364,700	226,600	161,700	136,400	71,600	15,300
Deaths								
Men (number)	153,552	4,481	8,122	14,804	31,674	50,359	36,877	7,235
Women (number)	107,268	2,449	5,368	8,264	14,726	29,871	34,796	11,794
Education								
Men								
University degree†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.17	1.33	1.32	1.40	1.28	1.14	1.04‡	0.89‡
Secondary graduation	1.42	1.89	1.76	1.74	1.55	1.32	1.11	0.95‡
Less than secondary graduation	1.71	2.86	2.39	2.26	1.94	1.55	1.21	1.10
Women								
University degree†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Postsecondary diploma	1.13	1.24	1.29	1.18	1.21	1.11	1.04‡	0.90‡
Secondary graduation	1.26	1.55	1.46	1.37	1.39	1.24	1.11	0.95‡
Less than secondary graduation	1.45	2.41	2.05	1.75	1.74	1.44	1.19	0.98‡
Occupation								
Men								
Professional†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.12	1.03‡	1.10	1.09	1.23	1.09	1.14	0.95‡
Skilled/Technical/Supervisory	1.34	1.41	1.50	1.46	1.39	1.11	1.06‡	1.03‡
Semi-skilled	1.53	1.80	1.86	1.72	1.56	1.21	1.18	0.89‡
Unskilled	1.72	2.18	2.15	1.97	1.70	1.24	1.18	1.08‡
No occupation	2.29	5.89	6.17	4.56	2.47	1.62	1.38	1.67
Women								
Professional†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Managerial	1.19	1.01‡	1.15‡	1.20	1.21	1.33	0.97‡	2.14
Skilled/Technical/Supervisory	1.26	1.13‡	1.23	1.24	1.24	1.21	1.13‡	2.03
Semi-skilled	1.28	1.42	1.35	1.27	1.25	1.19	1.18‡	1.69
Unskilled	1.45	1.60	1.65	1.41	1.45	1.34	1.21‡	1.67
No occupation	1.85	2.56	2.44	2.37	1.96	1.64	1.22	2.20
Income adequacy quintile								
Men								
Quintile 5 - richest†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.15	1.12	1.18	1.17	1.20	1.15	1.06	1.07‡
Quintile 3	1.27	1.25	1.25	1.33	1.38	1.24	1.11	1.06‡
Quintile 2	1.45	1.51	1.46	1.61	1.58	1.42	1.18	1.12
Quintile 1 - poorest	1.76	2.34	2.45	2.47	2.15	1.64	1.31	1.15
Women								
Quintile 5 - richest†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quintile 4	1.09	1.02‡	1.07‡	1.15	1.18	1.12	1.02‡	0.93‡
Quintile 3	1.16	1.12‡	1.22	1.31	1.28	1.15	1.05	0.93‡
Quintile 2	1.27	1.39	1.47	1.48	1.52	1.27	1.04‡	0.90
Quintile 1 - poorest	1.47	2.07	2.20	2.34	2.00	1.49	1.11	0.94‡
Income adequacy decile								
Men								
Decile 10 - richest†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Decile 9	1.11	1.03‡	1.05‡	1.12	1.18	1.15	1.05‡	1.04‡
Decile 8	1.18	1.09‡	1.20	1.19	1.25	1.19	1.10	1.07‡
Decile 7	1.24	1.18	1.22	1.28	1.34	1.25	1.07	1.09‡
Decile 6	1.30	1.21	1.27	1.35	1.43	1.31	1.13	1.07‡
Decile 5	1.36	1.31	1.30	1.46	1.56	1.32	1.14	1.08‡
Decile 4	1.47	1.41	1.41	1.62	1.63	1.46	1.18	1.14
Decile 3	1.55	1.69	1.61	1.79	1.79	1.56	1.22	1.15
Decile 2	1.72	2.08	2.07	2.18	2.11	1.72	1.33	1.19
Decile 1 - poorest	2.13	2.65	2.89	2.92	2.47	1.82	1.32	1.08‡
Women								
Decile 10 - richest†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Decile 9	1.07	0.84‡	1.02‡	1.10	1.20	1.06‡	1.04‡	0.98‡
Decile 8	1.12	0.94‡	1.04‡	1.23	1.24	1.14	1.04‡	0.93‡
Decile 7	1.13	0.92‡	1.11‡	1.18	1.32	1.15	1.04‡	0.90‡
Decile 6	1.18	0.98‡	1.26	1.33	1.37	1.13	1.07‡	0.95‡
Decile 5	1.22	1.06‡	1.20	1.42	1.43	1.22	1.08	0.89
Decile 4	1.26	1.23	1.38	1.48	1.59	1.28	1.00‡	0.91‡
Decile 3	1.34	1.32	1.61	1.62	1.71	1.32	1.09	0.87
Decile 2	1.44	1.52	1.86	2.04	1.93	1.49	1.12	0.94‡
Decile 1 - poorest	1.67	2.15	2.52	2.72	2.36	1.67	1.17	0.92‡
Activity limitation								
Men								
Not limited†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Limited	2.09	4.17	3.69	3.10	2.39	2.00	1.71	1.58
Women								
Not limited†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Limited	2.04	5.18	3.77	3.32	2.68	2.14	1.70	1.48

† reference category
‡ not significantly different from reference category ($p < 0.05$)
Notes: Mortality hazard ratios were adjusted for age in single years. Census population counts were rounded to nearest 100.
Source: Census mortality follow-up study, 1991 to 2001.

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Motor vehicle accident deaths, 1979 to 2004

by Pamela L. Ramage-Morin

Abstract

This article reviews motor vehicle accident (MVA) deaths from 1979 through 2004, with a more in-depth look from 2000 onwards. The data are from the Vital Statistics Death Database. Crude and age-standardized death rates were used to examine mortality over time. Average annual death rates were compared by age, sex and other selected characteristics. The average daily number of deaths was used to show seasonal fluctuations. Deaths resulting from motor vehicle accidents declined from 25 deaths per 100,000 population in 1979 to 9 deaths per 100,000 population in 2004. Despite this decline, motor vehicle accidents remain a leading cause of death for young people. From 2000 through 2004, MVA deaths accounted for 1.3% of all deaths Canada, but 17.3% of all deaths among people younger than 30. Males consistently had higher MVA death rates than did females

Keywords

Mortality, motor vehicle accidents, vital statistics

Author

Pamela L. Ramage-Morin (1-613-951-1760; pamela.ramage-morin@statcan.ca) is with the Health Information and Research Division at Statistics Canada, Ottawa, Ontario, K1A 0T6.

In 2004, there were 21.6 million licensed drivers in Canada[1] among a population of 25.8 million people aged 16 or older.[2] They operated over 25 million registered vehicles.[3] Most of these vehicles (76%) were cars, trucks, buses and motorcycles for on-road use, while a smaller proportion were farm, construction and off-road vehicles.

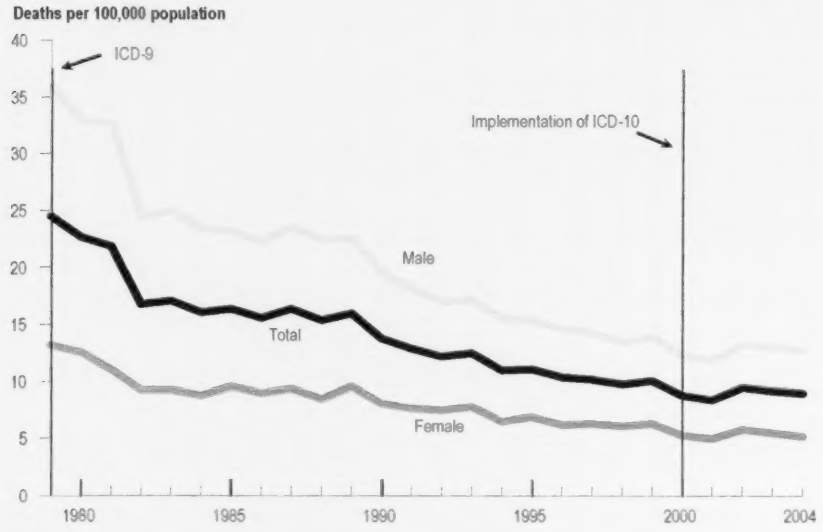
Despite the ever-increasing number of drivers and vehicles, fatal collisions and those resulting in personal injury have steadily declined over the past 20 years.[1] Even so, motor vehicle accidents remain a leading cause of death for young people.

From 2000 through 2004, there were 44,192 accidental deaths in Canada; 32% of them (14,082) were the result of motor vehicle accidents (MVAs). In the 15 to 24 age group, MVA deaths (3,417) accounted for 70% of all accidental deaths (4,895).

Many competing factors increase or decrease the risk of motor vehicle accidents and injuries. Technological advances such as anti-lock braking, airbags, improved seat belts and child restraints make vehicles safer.[4-6] Legislation and enforcement of speed limits, blood alcohol levels, seat belt use, bicycle helmets for children, and other safety measures are intended to protect vehicle occupants, pedestrians and cyclists.[7] Changing social norms discourage drinking and driving.[8]

However, the motor vehicle safety picture is not entirely positive. While seat belt technology has improved and legislation mandates their use, many adults still fail to "buckle up"—themselves or their children.[9] Related problems include car and booster seats that are incorrectly installed or placed in high-risk positions (front passenger seat, for example), and children who are not using age- or size-appropriate restraints.[5] The widespread use of cellphones, navigation systems and other telematic devices add to driver distraction.[10,11] Driving under the influence of alcohol, although declining, continues to be a problem, particularly among young drivers.[12] Driving under the influence of cannabis is a related concern.[13] Rural roads pose another threat—in 2004, 62% of collisions resulting in a fatality were in rural areas.[1] Weather frequently plays a part in motor

Figure 1
Crude death rate for motor vehicle accident, by sex, Canada, 1979 to 2004



Source: Canadian Vital Statistics - Death Database

vehicle accidents, as does human error such as fatigued and drowsy driving.[14] "Road rage," a term first coined in 1988,[15] which describes "uncontrolled anger that results in violence or threatened violence on the road,"[16] reflects an extreme form of human error.

This study reviews motor vehicle accident deaths in Canada from 1979 through 2004, with a more in-depth look from 2000 onwards. Data are from the Canadian Vital Statistics - Death Database which is composed of information from death certificates. Pedestrian and pedal cyclist fatalities are included if a motor vehicle was involved in the accident. Traffic and non-traffic (off-road) deaths are reported in the study.

Decline since 1979

Over the past 25 years, the annual number of Canadians who died from

Table 1
Number and rates (crude and age-standardized) of motor vehicle accident deaths, by sex, Canada, 1979 to 2004

	Both sexes			Males			Females		
		Deaths per 100,000 population			Deaths per 100,000 population			Deaths per 100,000 population	
	Number	Crude	Standard-ized	Number	Crude	Standard-ized	Number	Crude	Standard-ized
1979	5,933	24.5	24.5	4,327	35.9	35.9	1,606	13.2	13.2
1980	5,560	22.7	22.7	4,014	32.9	32.9	1,546	12.6	12.5
1981	5,443	21.9	21.9	4,054	32.8	32.8	1,389	11.1	11.1
1982	4,232	16.8	16.9	3,061	24.5	24.5	1,171	9.3	9.3
1983	4,334	17.1	17.2	3,153	25.0	25.1	1,181	9.3	9.3
1984	4,133	16.1	16.3	2,995	23.5	23.7	1,138	8.8	8.8
1985	4,234	16.4	16.5	2,980	23.2	23.4	1,254	9.6	9.7
1986	4,072	15.6	15.9	2,891	22.3	22.7	1,181	9.0	9.1
1987	4,342	16.4	16.8	3,093	23.6	24.1	1,249	9.4	9.5
1988	4,133	15.4	15.9	2,985	22.5	23.1	1,148	8.5	8.6
1989	4,376	16.0	16.4	3,053	22.6	23.1	1,323	9.6	9.8
1990	3,824	13.8	14.2	2,691	19.6	20.2	1,133	8.1	8.2
1991	3,612	12.9	13.4	2,522	18.2	18.9	1,090	7.7	7.8
1992	3,456	12.2	12.6	2,389	17.0	17.7	1,067	7.5	7.5
1993	3,573	12.5	13.0	2,445	17.2	18.0	1,128	7.8	8.0
1994	3,195	11.0	11.4	2,246	15.6	16.4	949	6.5	6.6
1995	3,256	11.1	11.5	2,238	15.4	16.1	1,018	6.9	7.0
1996	3,088	10.4	10.8	2,157	14.7	15.2	931	6.2	6.4
1997	3,055	10.2	10.7	2,110	14.3	14.9	945	6.3	6.5
1998	2,947	9.8	10.0	2,016	13.5	14.0	931	6.1	6.1
1999	3,084	10.1	10.4	2,110	14.0	14.4	974	6.3	6.4
2000	2,696	8.8	9.0	1,871	12.3	12.6	825	5.3	5.3
2001	2,617	8.4	8.6	1,835	11.9	12.2	782	5.0	4.9
2002	2,988	9.5	9.5	2,063	13.3	13.3	925	5.8	5.7
2003	2,906	9.2	9.3	2,034	13.0	13.2	872	5.5	5.3
2004	2,875	9.0	9.1	2,035	12.8	13.0	840	5.2	5.1
Total	**97,964**	...	...	**69,368**	...	...	**28,596**	...	...

... not applicable
Notes: Ninth Revision of the International Classification of Diseases from 1979 to 1999; Tenth Revision from 2000 to 2004. Age-standardized to 1981 Canadian population. Includes deaths coded as "late effects or "sequelae" of MVAs.
Source: Canadian Vital Statistics - Death Database.

motor vehicle accidents dropped by 52%, from 5,933 in 1979 to 2,875 in 2004 (Table 1). There were 97,964 MVA deaths over this period, the majority (71%) involving males.

In 1979, the MVA crude death rate was 24.5 deaths per 100,000 population, 35.9 and 13.2 deaths per 100,000 for males and females, respectively (Table 1, Figure 1). By 2004, these rates had dropped drastically to 12.8 per 100,000 population for males and 5.2 for females, for an overall rate of 9.0 deaths per 100,000 population. The close correspondence between the crude and age-standardized rates (Table 1) indicates that factors other than the changing age structure of the Canadian population between 1979 and 2004 account for the decline.

Death rates by province and territory

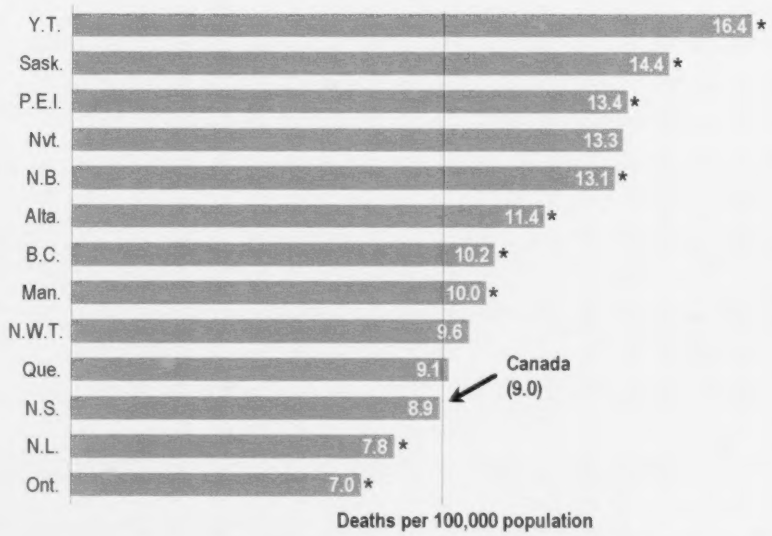
From 2000 through 2004, there were 14,082 MVA deaths in Canada, for an average annual average death rate of 9.0 per 100,000 population (Figure 2). Rates varied across the country, with the highest in the Yukon (16.4 per 100,000 population). Prince Edward Island, New Brunswick, Manitoba, Saskatchewan, Alberta and British Columbia also had rates above the national figure. Only Ontario and Newfoundland and Labrador had rates below the Canada level, at 7.0 and 7.8 per 100,000 population, respectively.

A leading cause of death for teens and young adults

From 2000 through 2004, MVA deaths accounted for 1.3% of all deaths in Canada. However, almost one in five deaths (17.3%) of people younger than 30 resulted from a motor vehicle accident.

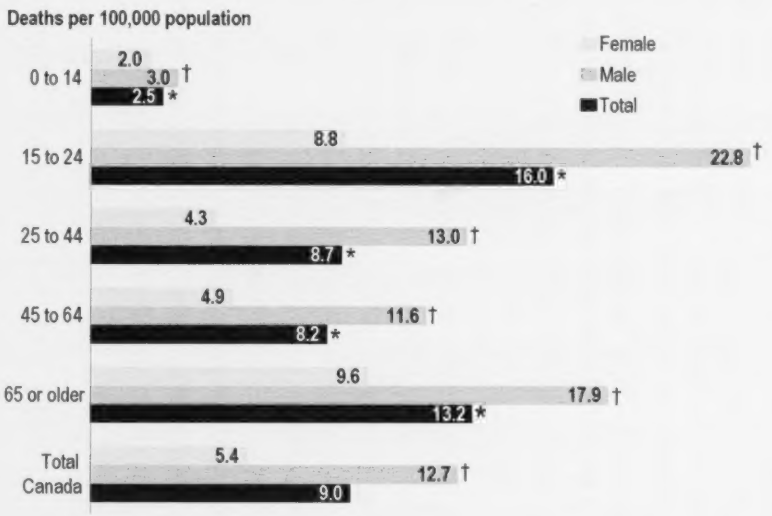
The average annual MVA death rate for 15- to 24-year-olds was 16 deaths per 100,000 population, significantly higher than the rate for all age groups combined (9 deaths per 100,000 population) (Figure 3). Seniors (65 or older) also had a rate above the national level at 13 deaths per 100,000

Figure 2
Average annual rate of death from motor vehicle accident, by province or territory, Canada, 2000 to 2004



* significantly different from estimate for Canada ($p < 0.05$)
Source: Canadian Vital Statistics - Death Database.

Figure 3
Average annual rate of death from motor vehicle accident, by age and sex, Canada, 2000 to 2004



* significantly different from rate for Total Canada ($p < 0.05$)
† significantly different from rate for females ($p < 0.05$)
Source: Canadian Vital Statistics - Death Database.

The data

Results for this study are based on Statistics Canada's Vital Statistics - Death Database, accessed through the Information Retriever/Metainformation Administrator (IRMA) software (July 2007). Data are extracted from death certificates submitted by the provinces and territories to Statistics Canada. Cause of death is coded according to World Health Organization's *International Statistical Classification of Diseases and Related Health Problems (ICD).*

Deaths resulting from *motor vehicle accidents (MVA)* are defined by groups of codes from the International Classification of Diseases (ICD).[17-19] The Ninth Revision was in use from 1979 to 1999, after which ICD-10 was implemented.

ICD-9 codes: E810-E825, E929.0 (late effects of motor vehicle accident)

ICD-10 codes: V02-V04, V09.0, V09.2, V12-V14, V19.0-V19.2, V19.4-V19.6, V20-V79, V80.3-V80.5, V81.0-V81.1, V82.0-V82.1, V83-V86, V87.0-V87.8, V88.0-V88.8, V89.0, V89.2, Y85.0 (sequelae of motor-vehicle accident)

These codes include *traffic deaths*, which are those that occurred on public streets and highways, and *non-traffic deaths*, which occurred elsewhere. The codes reflect the victim's mode of transport, including *occupants* of cars, buses and other street vehicles, motorcycle riders, and operators of farm, construction and recreational vehicles such as snowmobiles and four-wheelers. Deaths of *pedestrians*, *pedal cyclists*, *riders of animals* and *occupants of animal-drawn vehicles* are included if the accident involved a motor vehicle. Appendix Table A contains a more detailed list of codes for mode of transport.

Sequelae of motor vehicle accident include conditions reported as such, or occurring as "late effects" one year or more after the originating event.

Implementation of the ICD-10 in 2000 has the potential to disrupt trends in the underlying cause of death statistics. A Statistics Canada study dual-coded 1999 deaths to the Ninth and Tenth Revisions of the ICD and generated comparability ratios.[20] The comparability ratio for MVAs is 0.9813 (95% CI: 0.9705, 0.9922) signifying that for 1999, 1.9% fewer deaths are classified to this group in ICD-10 than in ICD-9. Consequently, the disruption in the trend of MVA deaths is believed to be minimal.

The study is limited to Canadian residents. Of the 99,583 MVA deaths between 1979 and 2004, 1,619 (2%) involved non-residents, most of whom (981) were from the United States. These non-resident deaths are excluded from this study. Deaths of Canadian residents occurring in the United States are included, as these deaths are reported to provincial registrars under a reciprocal agreement.[21] However, deaths of Canadian residents occurring in other countries are not reported and are, therefore, excluded from this study.

The mortality data do not contain information about road conditions, the use of seat belts or child restraints, alcohol or drug use, driver distractions, or other circumstantial risk factors. In addition, analysis by mode of transport is limited, as a third of death certificates did not provide sufficient detail to be classified. A death resulting from a collision between a car and an off-road vehicle, for example, would be "unspecified" unless the death certificate specified whether the person was an occupant of the car or the driver of the off-road vehicle. This lack of information prevented a more detailed analysis by province.

population. Rates were lower for the remaining age groups, especially those younger than 15 (3 deaths per 100,000 population). Regardless of age group, males consistently had higher death rates than did females.

Most deaths vehicle occupants

From 2000 to 2004, more than a third (38%) of MVA deaths were occupants (drivers or passengers) of a car, van, truck, bus or other motor vehicle. Pedestrians accounted for 12% of MVA deaths, followed by motorcyclists (6%) and drivers of all-terrain or other off-road vehicles (5%). Pedal cyclists and operators of agricultural vehicles made up 2% and 1% of deaths, respectively. For the remaining third of the MVA deaths that occurred in that period (4,705), the deceased's mode of transport was not specified in the death certificate.

Looking specifically at the 5,388 deaths among occupants of motor vehicles, 1,499 (28%) were to people aged 15- to 24-years. Between 2000 and 2004 the average annual rate for this cause was over 3 deaths per 100,000 population (Figure 4). However, the rate for 15- to 24-year-olds was 7 deaths per 100,000, significantly higher than for any other age group. Young men were particularly at risk, with a rate of 10 deaths per 100,000, compared with 4 per 100,000 for women of the same age (data not shown).

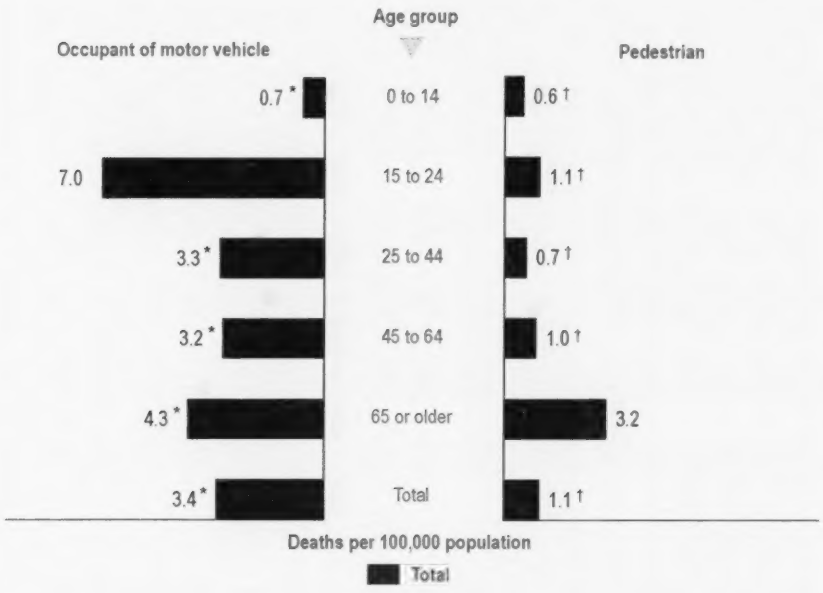
Deaths of senior pedestrians

A relatively large proportion of pedestrians killed in MVAs were seniors. Between 2000 and 2004, 1,746 pedestrians died in accidents involving motor vehicles; over a third of them (636) were 65 or older. Seniors' average annual death rate from this cause was over 3 per 100,000 population, compared with less than 1 per 100,000 for people in the under-65 age range (Figure 4).

Deaths peak in warmer months

From 2000 to 2004, an average of just under 8 Canadians died each day in motor vehicle accidents (Figure 5). However, the daily number of MVA deaths fluctuated across the seasons. For the most part, the daily average rose during the warmer months and was lowest from January through April. Deaths peaked in August 2004, with an average of more than 10 fatalities each day. The lowest number in any

Figure 4
Average annual rate of death as occupant of motor vehicle or pedestrian, by age group, Canada, 2000 to 2004



* significantly different from rate for 15-to-24 age group ($p < 0.05$) (occupants of motor vehicles)
† significantly different from rate for 65 or older age group ($p < 0.05$) (pedestrians)
Source: Canadian Vital Statistics - Death Database.

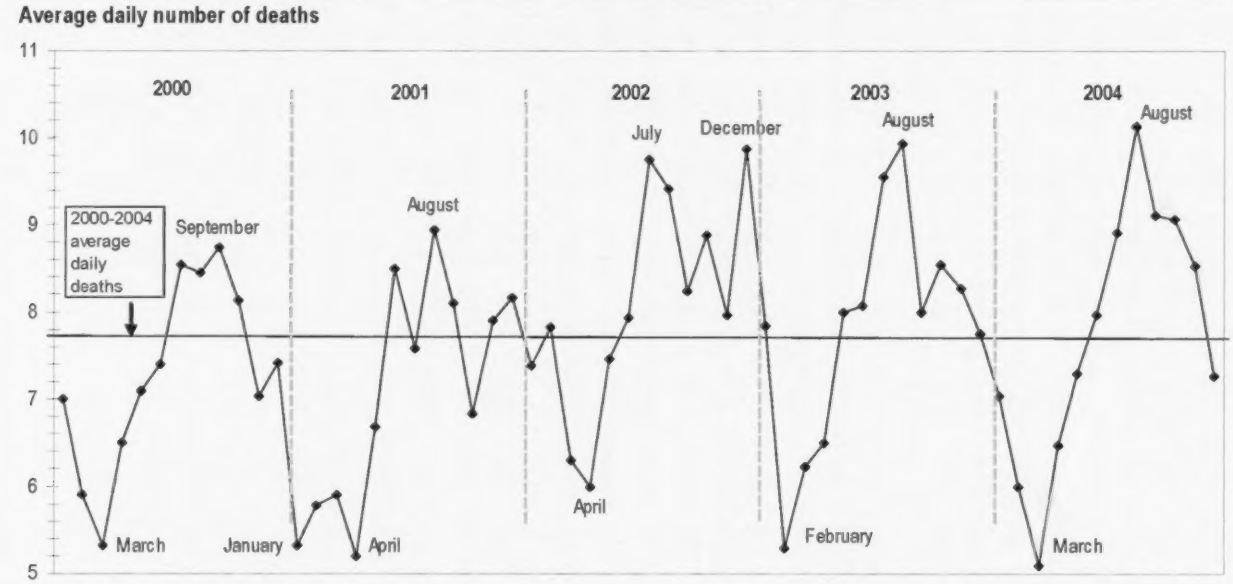
month was in March of the same year, with a daily average of 5 fatalities.

Conclusion

Deaths resulting from motor vehicle accidents have declined since 1979. Despite this, they remain a leading cause of death for young people.

There are opportunities to lower the risk of motor vehicle accidents and the injuries and deaths that result. Measures that help prevent accidents and those that minimize harm in the event of an accident are two approaches. Strategies that fall in the first category include reducing distractions from cell phones and other telematic devices, as well as addressing driving under the influence of alcohol and drugs. Adult seat belt use and age- and size-appropriate restraints for young people fall in the second category. Many strategies aimed at motor vehicle occupants could also benefit more vulnerable road users such as pedestrians and cyclists. Younger and older motorists, as well as senior pedestrians, are particularly at risk with higher than average death rates.

Figure 5
Average daily number of deaths from motor vehicle accident, by month, Canada, 2000 to 2004



Note: Excludes sequelae of MVAs (172 cases).
Source: Canadian Vital Statistics - Death Database.

References

1. Transport Canada. *Canadian Motor Vehicle Traffic Collision Statistics: 2004* (Catalogue T45-3/2004), TP 3322, December 2005. Available at: http://www.tc.gc.ca/roadsafety/tp/tp3322/2004/menu.htm. Accessed 18 September, 2007.
2. Statistics Canada, *Estimates of Population by Age and Sex for Canada, Provinces and Territories*, CANSIM Table 051-0001.
3. Statistics Canada, *Road Motor Vehicles – Registration*, CANSIM Table 405-0004.
4. Transport Canada, Road Safety Directorate and Motor Vehicle Regulation Directorate. *Evaluation of the Effectiveness of Air Bags and Seat Belts: Estimates of Lives Saved among Front Seat Occupants of Light Duty Vehicles Involved in Collisions Attributable to the Use of Seat Belts and Air Bags in Canada*. Fact Sheet, RS 2001-03 E, TP# 13187. October 2001. Available at: http://www.tc.gc.ca/roadsafety/tp2436/rs200103/pdf/rs200103e.pdf. Accessed 18 September, 2007.
5. Howard AW. Automobile restraints for children: a review for clinicians. *Canadian Medical Association Journal* 2002; 167(7): 769-73.
6. Transport Canada. *About Anti-lock Braking Systems (ABS)*. Available at: http://www.tc.gc.ca/roadsafety/tp/tp13082/abs1_e.htm. Accessed 18 September, 2007.
7. Transport Canada, Road Safety and Motor Vehicle Regulation Directorate. *Canada's Road Safety Targets to 2101*. TP# 13736. March 2001. Available at: http://www.tc.gc.ca/roadsafety/vision/menu.htm. Accessed November 19, 2007.
8. Transport Canada. *Smashed: Impaired Driving in Canada: Progress... but the Journey Continues*. Available at: http://www.tc.gc.ca/roadsafety/tp/tp1535/progress.htm Accessed 18 September, 2007.
9. Halman SI, Chipman M, Parkin PC, Wright JG. Are seat belt restraints as effective in school age children as in adults? A prospective crash study. *British Medical Journal* 2002; 324.
10. Harbluk JL, Noy YI. *The Impact of Cognitive Distraction on Driver Visual Behaviour and Vehicle Control*. Transport Canada, Road Safety Directorate and Motor Vehicle Regulation Directorate and EL-MAR Inc. TP# 13889, February 2002. Available at: http://www.tc.gc.ca/roadsafety/tp/tp13889/pdf/tp13889es.pdf. Accessed October 3, 2007.
11. Transport Canada, Road Safety and Motor Vehicle Regulations Directorate. *Strategies for Reducing Driver Distraction from In-vehicle Telmatics Devices: A Discussion Document*. TP 14133 E. April 2003. Available at: http://www.tc.gc.ca/roadsafety/tp/tp14133/pdf/tp14133e.pdf. Accessed 18 September, 2007.
12. Janhevich D, Gannon M, Morisset N. Impaired driving and other traffic offences, 2002. *Juristat* (Statistics Canada, Catalogue 85-002) 2003; 23(9).
13. Mann RE, Brands B, Macdonald S, Stoduto G. *Impacts of Cannabis on Driving: An Analysis of Current Evidence with Emphasis on Canadian Data*. TP 14179 E, May 2003. Available at: http://www.tc.gc.ca/roadsafety/tp/tp14179/Impacts%20of%20cannabis_E_v3.pdf. Accessed September 18, 2007.
14. Traffic Injury Research Foundation. "A wake-up call for Ontario drivers: new poll on fatigued and drowsy driving reveals serious problem." Press release: July 9, 2007. Available at: http://www.trafficinjuryresearch.com/whatNew/whatNew.cfm. Accessed October 4, 2007.
15. Schuchardt RM. Understanding road rage. *Counterblast: E-journal of Culture and Communication* 2001; 1(1). Available at http://www.nyu.edu/pubs/counterblast/issue1_nov01/articles/schuchardt.html. Accessed October 4, 2007.
16. Rathbone DB, Huckabee JC. *Controlling road rage: a literature review and pilot study*. Prepared for the AAA Foundation for Traffic Safety, June 9, 1999. Available at at: http://www.aaafoundation.org/resources/index.cfm?button=roadrage. Accessed November 19, 2007.
17. World Health Organization (WHO). *International Statistical Classification of Diseases, Injuries, and Causes of Death, Ninth Revision (ICD-9)*. World Health Organization: Geneva, 1975.
18. World Health Organization (WHO). *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)*. World Health Organization: Geneva, 1992.
19. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics. *Instruction Manual, Part 9: ICD-10 Causes-of-Death Lists for Tabulating Mortality Statistics*. Maryland: January, 2007.
20. Statistics Canada. *Comparability of ICD-10 and ICD-9 for Mortality Statistics in Canada* (Catalogue 84-548) Minister of Industry: Ottawa, 2005.
21. Statistics Canada. *Deaths, 1999*, Shelf tables (Catalogue 84F0211XPB) Statistics Canada: Ottawa, 2002.

Table A
ICD-10 codes for motor vehicle accidents, by mode of transport

Motor vehicle occupant (includes three-wheeled motor vehicle, car, pick-up truck or van, heavy transport vehicle, and bus)
V30 - V79
V87.0, V87.2 - V87.5
V88.0, V88.2 - V88.5

Pedestrian (includes person making adjustment to a motor vehicle, changing wheel of vehicle, or using a pedestrian conveyance such as a baby carriage, push cart, roller-skates, scooter, skateboard, or wheelchair)
V02 - V04
V09.0
V09.2

Motor cyclist (includes moped, motorcycle with sidecar, motor scooter, motorized bicycle)
V20 - V29

Pedal cyclist (includes bicycle and tricycle)
V12 - V14
V19.0 - V19.2
V19.4 - V19.6

All terrain (ATV) and other off-road vehicles (includes snowmobile)
V86

Agricultural vehicles (includes motor vehicles for use in farming such as combine harvester, tractor and trailer, and other motor vehicles designed specifically to work the land, tend and harvest crops, and transport materials on the farm)
V84

Other vehicles (includes rider/occupant of animal-drawn vehicle, occupant of railway train, streetcar, industrial, and construction vehicles)
V80.3 - V80.5
V81.0 - V81.1
V82.0 - V82.1
V83
V85

Unspecified vehicle (traffic and non-traffic, mode of transport unspecified)
V87.1, V87.6 - V87.8
V88.1, V88.6 -V 88.8
V89.0
V89.2

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Trends in teen sexual behaviour and condom use

by Michelle Rotermann

Abstract

Results from the 1996/1997 National Population Health Survey and the 2003 and 2005 Canadian Community Health Survey suggest that the proportion of teens who have had sexual intercourse has declined. In 2005, 43% of 15- to 19-year-olds reported that they had had sexual intercourse at least once, down from 47% in 1996/1997. As well, the proportion of teens reporting that they had become sexually active before age 15 declined. About one-third of those who had had intercourse in the previous year did so with more than one partner. Condom use was reported by around three-quarters of sexually active 15- to 19-year-olds who had had multiple partners or who were not married or in a common-law relationship

Keywords

adolescent behaviour, coitus, contraception behaviour, sexual intercourse, sexual partners

Author

Michelle Rotermann (Michelle.Rotermann@statcan.ca; 613-951-3166) is with the Health Information and Research Division at Statistics Canada in Ottawa, Ontario, K1A 0T6.

Sexual intercourse at an early age, having multiple sexual partners, and unprotected sex put teens at risk of sexually transmitted infection (STI) and of unwanted pregnancy. Since the mid-1990s, some of these behaviours have become less prevalent, while the prevalence of others has not changed or has increased. However, trends differ by age, gender and jurisdiction.

This article presents recent trends in sexual behaviours among Canadian teenagers, based on nationally representative surveys conducted in 1996/1997, 2003 and 2005.

Sexual activity

In 2005, 43% of teens aged 15 to 19 reported that they had had sexual intercourse at least once, down from 47% in 1996/1997 (Table 1). All of the decline reflected the behaviour of young women, among whom the proportion reporting ever having had intercourse fell from 51% to 43%. The proportion of young men who reported having had intercourse remained at 43%.

Throughout the period, the percentage of teens reporting sexual intercourse was higher at older ages. About one-third of 15- to 17-year-olds had had intercourse, compared with about two-thirds of 18- and 19-year-olds.

In 2005, 58% of Quebec teens reported having had sexual intercourse, significantly above the estimate for the rest of Canada (the other provinces combined); the proportions were 37% in Ontario and 40% in British Columbia, which were significantly lower. The remaining provinces did not differ from the rest of Canada.

From 1996/1997 to 2005, the proportion of Nova Scotia teens reporting that they had had sexual intercourse rose from 31% to 49%, while the figure fell from 41% to 37% among those in Ontario. In Prince Edward Island and New Brunswick, 2005 figures were down substantially from 2003 estimates.

Table 1
Number and percentage of 15- to 19-year-olds who had sexual intercourse at least once, by gender, age group and province, Canada excluding territories, 1996/1997, 2003 and 2005

	1996/1997		2003		2005	
	'000	%	'000	%	'000	%
Total	920	47*	862	45	868	43
Gender						
Males†	434	43	437	46	432	43
Females	486	51‡*	425	45	435	43
Age group						
15 to 17†	380	32	348	30	362	29
18 to 19	540	70‡	514	68‡	506	65‡
Province						
Newfoundland and Labrador	23	46	19	54‡	17	49
Prince Edward Island	4E	37E	5	52*	3	35
Nova Scotia	16E	31‡*E	29	49	29	49
New Brunswick	28E	43E	24	52*‡	19	43
Quebec	297	59‡	252	62‡	263	58‡
Ontario	269	41*‡	302	40‡	302	37‡
Manitoba	30	39‡	31	43	27	39
Saskatchewan	38E	54	27	39‡	28	43
Alberta	82	44	80	39‡	77	39
British Columbia	133	47	93	37‡	103	40‡

† reference category
* significantly different from corresponding estimate for 2005 ($p < 0.05$)
‡ significantly different from estimate for reference category or within year rest of Canada ($p < 0.05$)
E use with caution (coefficient of variation 16.6 to 33.3%)
Note: Because of rounding, counts may not add to total.
Sources: 1996/1997 National Population Health Survey, 2003 Canadian Community Health Survey, cycle 2.1, 2005 Canadian Community HealthSurvey, cycle 3.1.

Table 2
Number and percentage of 15- to 19-year-olds who had sexual intercourse before age 15 or at ages 15 and 16, by gender and age group, Canada excluding territories, 1996/1997, 2003 and 2005

Age when first had sexual intercourse	1996/1997		2003		2005	
	'000	%	'000	%	'000	%
Total						
Less than 15	230	12*	172	9	162	8
15 to 16	428	22	420	22	426	21
Gender						
Males						
Less than 15	104	11	87	9	80	8
15 to 16	194	20	206	22	215	22
Females						
Less than 15	126	13*	85	9	82	8
15 to 16	234	25	214	23	210	21
Age group						
15 to 17						
Less than 15	138	12*	95	8	99	8
15 to 16	213	18	213	19	225	18
18 to 19						
Less than 15	92	12*	76	10	63	8
15 to 16	215	28	207	28	200	26

* significantly different from corresponding estimate for 2005 ($p < 0.05$)
Notes: Comprises sexually active and sexually inactive 15- to-19-year-olds. Because of rounding, counts may not add to totals.
Sources: 1996/1997 National Population Health Survey, 2003 Canadian Community Health Survey, cycle 2.1, 2005 Canadian Community HealthSurvey, cycle 3.1.

Early sexual intercourse

The younger a person is when he or she becomes sexually active, the longer they are at risk of unwanted pregnancy or of contracting a sexually transmitted infection.[1] Research has also shown that an early age at first intercourse is related to risk behaviours such as unprotected sex, alcohol consumption and smoking.[2-5] The proportion of teens who reported having had sexual intercourse before they were 15 years old fell from 12% in 1996/1997 to 8% in 2005 (Table 2). Among girls, the percentage reporting intercourse before age 15 decreased, while among boys, the figure did not change significantly. As well, in 2005, the proportions of both 15- to 17-year-olds and 18- and 19-year-olds reporting early sexual intercourse were significantly lower than in 1996/1997.

Multiple partners

The number of sexual partners is an important indicator of sexual risk behaviour, particularly with respect to contracting an STI.[6,7] In 2005, about one-third of the 15- to 19-year-olds who had had intercourse in the past year reported having done so with more than one partner, around the same percentage as in 1996/1997 (Table 3). Throughout the period from 1996/1997 to 2005, males were more likely than females to report having had multiple partners in the past year, a finding consistent with other studies.[4-8] Having had sex with more than one partner was more common at older ages. In 2005, 36% of 18- to 19-year-olds reported having had multiple partners in the past year, compared with 29% of 15- to 17-year-olds.

Condom use

Condom use is a means of preventing unplanned pregnancies and reducing the risk of contracting a STI. In 2005, three-quarters of sexually active 15-to-19-year-olds who had been with multiple partners in the past year and/or who were not married or in a common-

Table 3
Number and percentage of sexually active 15- to 19-year-olds who reported having multiple partners in past year, by gender and age group, Canada excluding territories, 1996/1997, 2003 and 2005

	1996/1997		2003		2005	
	'000	%	'000	%	'000	%
Total	231	29	271	35	261	33
Gender						
Males†	123	35	154	40	151	40
Females	108	25‡	117	30‡	110	27‡
Age group						
15 to 17†	85	27	107	35*	95	29
18 to 19	146	31	164	35	166	36‡

† reference category
‡ significantly different from estimate for reference category ($p < 0.05$)
* significantly different from corresponding estimate for 2005 ($p < 0.05$)
Sources: 1996/1997 National Population Health Survey; 2003 Canadian Community Health Survey, cycle 2.1; 2005 Canadian Community HealthSurvey, cycle 3.1.

law relationship reported using a condom the last time they had intercourse (Table 4). Males were considerably more likely than females to report having used a condom, a finding consistent with other studies.[1,2,9-11] From 2003 to 2005 (the only years for which nationally representative and comparable data are available), the proportion of sexually active young women who reported condom use rose from 65% to 70%; among young men, the proportion remained around 80%.

In 2005, condom use was more common at ages 15 to 17 than at ages

The data

The prevalence of sexual intercourse and condom use and the number of sexual partners among 15- to 19-year-olds were estimated from the 1996/1997 National Population Health Survey (NPHS) cross-sectional file and from cycles 2.1 and 3.1 of the Canadian Community Health Survey (CCHS).

Respondents to the cross-sectional component of the NPHS were surveyed from June 1996 to August 1997, with an overall response rate of 83%. The sample aged 15 to 19 for the questions about sexual intercourse and age at first intercourse numbered 4,449; the analyses of multiple partners were based on a sample of 3,600. Both samples were weighted to represent a population of approximately 2.1 million. Virtually all the NPHS data (98.5%) were collected in telephone interviews. Details of the design and sampling techniques have been described elsewhere.[12]

Cycle 2.1 of the CCHS was conducted from January to December in 2003; cycle 3.1, from January to June in 2005. The response rates for cycle 2.1 and cycle 3.1 were 81% and 79%, respectively. The samples used for this article numbered 11,022 and 9,874 respondents aged 15 to 19, weighted to represent populations of approximately 2 million and 2.1 million, respectively. Telephone interviews accounted for 70% of all cycle 2.1 interviews, and 61% of cycle 3.1 interviews. Details of the CCHS design and sampling techniques have been published elsewhere.[13]

All differences were tested to ensure statistical significance, which was established at the 0.05 level. To account for survey design effects, standard errors and coefficients of variation were estimated using the bootstrap technique.[14,15]

The percentage of 15- to 19-year-olds who had had sexual intercourse at least once was based on yes/no responses to the following question in the NPHS and in cycles 2.1 and 3.1 of the CCHS: "Have you ever had sexual intercourse?" Respondents were asked how old they were "the first time," which was used to calculate the proportions who became sexually active at age 14 or younger, and at ages 15 and 16. The percentage who had had sexual intercourse with more than one person in the past year was based on the number of partners respondents said they had had in the previous 12 months. Estimates of condom use among sexually active young people who had been with multiple partners in the past year and/or who were not married or not in a common-law relationship were based on responses to: "Did you use a condom the last time you had intercourse?" Because condom use referred to the most recent sexual encounter, it does not necessarily reflect typical behaviour. It is also possible that the question itself generated confusion among respondents, as it does not specifically ask about male versus female condom use.

The mode of data collection can influence response rates, data quality and non-sampling errors, notably bias.[16,17] "Social desirability," which has been identified as a source of bias in the CCHS,[13] may be especially relevant to this analysis. Social desirability refers to a tendency for respondents to modify their answers in an effort to construct a more favourable image of themselves. Some studies have found that face-to-face interviews are more susceptible to this type of bias than are telephone interviews, while others have found that respondents interviewed by telephone are less likely to share or accurately report potentially embarrassing attitudes or behaviours.[18,19] Thus, social desirability has the potential to result in both over- and underestimation of a particular behaviour, since the perception of what is "desirable" may differ depending on a respondent's age, gender and socio-economic status. Some teens may give socially acceptable answers (under-report) to questions about sexual behaviour; others may exaggerate their sexual experience.

Differing proportions of the interviews in three surveys used for this analysis were conducted by telephone. To ascertain the impact of these differences, analyses were rerun for the subset of respondents from each survey who were interviewed by telephone. The results were generally the same as those for the full sample (data not shown), thereby lending support to the stability and credibility of the original estimates.

The term "sexual intercourse" was not defined in the NPHS or CCHS questions, so it is possible that some teens may have misinterpreted the question. As well, recall errors are possible.

Table 4
Number and percentage of sexually active 15- to 19-year-olds who used a condom the last time they had intercourse, by gender, age group and province, Canada excluding territories, 2003 and 2005

	2003		2005	
	Number	%	Number	%
Total	**541**	**72**	**567**	**75**
Gender				
Males†	300	79	298	80
Females	241	65*‡	269	70‡
Age group				
15 to 17†	238	79	260	81
18 to 19	303	68‡	307	70‡
Provinces				
Newfoundland and Labrador	11	73	12	80
Prince Edward Island	4	88‡	2	87‡
Nova Scotia	20	77*	23	90‡
New Brunswick	16	74	13	79
Québec	143	66*‡	150	66‡
Ontario	199	75‡	208	77
Manitoba	21	76	17	72
Saskatchewan	18	75	19	78
Alberta	50	73	53	82‡
British Columbia	59	72	70	77

† reference category
* significantly different from corresponding estimate for 2005 ($p < 0.05$)
‡ significantly different from estimate for reference category or within year rest of Canada ($p < 0.05$)
Note: Data pertain to sexually active 15- to 19-year-olds who were not married or in a common-law relationship or who had multiple partners in past year.
Sources: 2003 Canadian Community Health Survey, cycle 2.1; 2005 Canadian Community HealthSurvey, cycle 3.1.

18 and 19. While 81% of the younger group reported that they had used a condom the last time they had intercourse, the figure for older teens was 70%. Previous research has shown condom use to decrease with age, to be less common among oral contraceptive users, and to be more common among individuals in short-term relationships.[2,4, 20-24]

In 2005, the percentage of 15- to 19-year-olds who reported that they had used a condom the last time they had sex was significantly higher in Prince Edward Island, Nova Scotia and Alberta, and significantly lower in Quebec, compared with the rest of Canada. Nova Scotia was the only province where teen condom use increased significantly between 2003 and 2005.

Conclusion

Based on a representative sample of 15- to 19-year-olds, the proportion of teens who had had sexual intercourse at least once declined between 1996/1997 and 2005. As well, the proportion who reported becoming sexually active at a very early age decreased. However, among those who were sexually active, there was no significant change in the likelihood of having multiple partners or, for males, using condoms. So while some adolescents have adopted measures to reduce their risks of sexually transmitted infection and unwanted pregnancy, others report high-risk behaviour.

References

1. Maticka-Tyndale E, Barrett M, McKay A. Adolescent sexual and reproductive health in Canada: a review of national data sources and their limitations. *The Canadian Journal of Human Sexuality* 2000; 9(1): 41-65.
2. Rotermann M. Sex, condoms and STDs among young people. *Health Reports* (Statistics Canada, Catalogue 82-003) 2005; 16(3): 39-45.
3. Garriguet D. Early sexual intercourse. *Health Reports* (Statistics Canada, Catalogue 82-003) 2005; 16(3): 9-16.
4. Galambos NL, Tilton-Weaver LC. Multiple-risk behaviour in adolescents and young adults. *Health Reports* (Statistics Canada, Catalogue 82-003) 1998; 10(2): 9-20.
5. Saab H. *Youth Health Risk Behaviours in HBSC: Health Behaviour in School-aged Children: A World Health Organization Cross-national Study*. Available at: http://www.hc-sc.gc.ca/dca-dea/7-18yrs-ans/hbschealth_e.html. Accessed October 10, 2007.
6. McKay A. Adolescent sexual and reproductive health in Canada: a report card in 2004. *The Canadian Journal of Human Sexuality* 2004; 13(2): 67-81.
7. Maticka-Tyndale E. *Reducing the Incidence of Sexually Transmitted Disease through Behavioural and Social change*. Available at: http://www.phac-aspc.gc.ca/publicat/cjhs/cjhs2.html. Accessed September 30, 2007.
8. Council of Ministers. *Canadian Youth, Sexual Health and HIV/AIDS Study – Factors Influencing Knowledge, Attitudes and Behaviours*. Available at: http://www.cmec.ca/publications/aids/. Accessed November 14, 2007.
9. Martin K, Wu Zheng. Contraceptive use in Canada: 1984-1995. *Family Planning Perspectives* 2000; 32(2): 65-73.
10. Ford K, Sohn W, Lepkowski J. Characteristics of adolescents' sexual partners and their association with use of condoms and other contraceptive methods. *Family Planning Perspectives* 2001; 33(3): 101-5, 132.
11. Santelli JS, Duberstein Lindberg L, Abma J, et al. Adolescent sexual behavior: estimates and trends from four nationally representative surveys. *Family Planning Perspectives* 2000; 32(4): 156-65, 194.
12. Tambay JL, Catlin G. Sample design of the national population health survey. *Health Reports* (Statistics Canada, Catalogue 82-003) 1995; 7(1): 29-38.
13. Beland Y. Canadian community health survey—methodological overview. *Health Reports* (Statistics Canada, Catalogue 82-003) 2002; 13(3): 9-14.
14. Rao JNK, Wu CFJ, Yue K. Some recent work on resampling methods for complex surveys. *Survey Methodology* (Statistics Canada, Catalogue 12-001) 1992: 18(2): 209-17.
15. Rust K, Rao JNK. Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research* 1996; 5: 281-310.
16. St.Pierre M, Béland Y. *Mode Effects in the Canadian Community Health Survey : A Comparison of CAPI and CATI*. Available at: http://www.statcan.ca/english/sdds/document/3226_D16_T9_V2_E.pdf
17. Singleton RA, Straits BC, Miller Straits M. *Approaches to Social Science Research, Second Edition*. Oxford: Oxford University Press, 1993.
18. Groves RM , Kahn RL. *Surveys by Telephone: A National Comparison with Personal Interviews*. New York: Academic Press, 1979.
19. Holbrook AL, Green MC, Krosnick JA. Telephone versus face-to-face interviewing of national probability samples with long questionnaires. *Public Opinion Quarterly* 2003; 67: 79-125.
20. Sonenstein FL, Ku L, Duberstein Lindberg L ,et al. Changes in sexual behavior and condom use among teenaged males: 1988 to 1995. *American Journal of Public Health* 1998; 88(6): 956-59.
21. Kangas I, Andersen B, McGarigle CA, et al. *A Comparison of Sexual Behaviour and Attitudes of Healthy Adolescents in a Danish High School in 1982, 1996, and 2001*. Available at: http://www.pophealthmetrics.com/content/2/1/5. Accessed September 1, 2007.
22. Rodrigues I, Dedobbeleer N, Turcot C. L'usage du condom chez les adolescentes consultant pour une contraception oral dans la région de Montréal. *Revue canadienne de Santé publique* 2005; 96(6): 438–42.
23. Bankole A, Darroch JE, Singh S. Determinants of trends in condom use in the United States, 1988-1995. *Family Planning Perspectives* 1999; 31(6): 264-71.
24. Lescano CM, Vazquez EA, Brown LK, et al. Condom use with "casual" and "main" partners: what's in a name? *Journal of Adolescent Health* 2006; 39: 443.e1-443.e7.

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Diabetes–prevalence and care practices

by Claudia Sanmartin and Jason Gilmore

Abstract

In 2005, an estimated 1.3 million Canadians aged 12 or older (4.9% of the population of these ages) reported to the Canadian Community Health Survey (CCHS) that they had been diagnosed with diabetes. The Canadian Diabetes Association has published Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada, which recommend the type of care that should be provided to individuals with diabetes. According to the CCHS, and based on data from six of the provinces/territories (Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory), almost three-quarters of diabetic respondents aged 18 or older reported having had their hemoglobin A1C checked by a health care professional at least once in the year before the survey, and those who had had the test were close to meeting the recommended frequency of every three months. The majority of diabetic respondents were also meeting the recommendation for eye examinations, but only half had the recommended annual foot examinations. Half the diabetic population reported that they or a family member had checked their glucose level every day.

Keywords

Diabetes mellitus, diabetic foot, diabetic retinopathy

Authors

Claudia Sanmartin (613-951-6059; Claudia.Sanmartin@statcan.ca) and Jason Gilmore (613-951-7118; Jason.Gilmore@statcan.ca) are with, respectively, the Health Information and Research Division and the Labour Statistics Division at Statistics Canada.

Diabetes is a serious chronic disease that affects the body's ability to produce or properly use insulin.[1] It can lead to various disabling and life-threatening complications such as heart disease and stroke, high blood pressure, and premature death.[2] In Canada, diabetes is the single largest cause of blindness, and a leading cause of kidney failure and lower limb amputations.[3] Diabetes is the seventh leading cause of death and accounts for 25,000 person-years of life lost before age 75.[2]

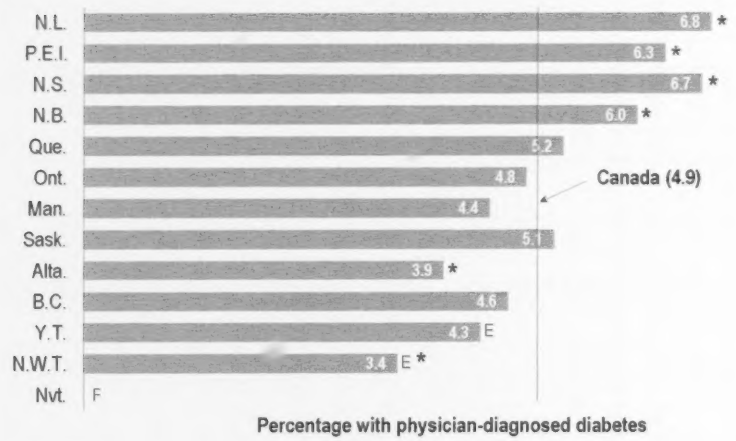
In 2005, 1.3 million Canadians aged 12 or older, or 4.9% of the population in this age group, reported that they were living with diabetes (Chart 1). This estimate, which reflects self-reports of physician-diagnosed diabetes, is based on recent national data from the Canadian Community Health Survey (CCHS) (see *Data source*). Prevalence was higher than the national average in all four Atlantic provinces: 6.0% in New Brunswick, 6.3% in Prince Edward Island, 6.7% in Nova Scotia, and 6.8% in Newfoundland and Labrador. In Alberta and the Northwest Territories, rates were significantly lower than the national average, at 3.9% and 3.4%, respectively.

Males aged 12 or older were slightly more likely (5.4%) than females (4.4%) to report having diabetes (Table 1). People younger than 45 were much less likely to have diabetes than were those aged 45 or older. Overall, in 2005, about one in five (19.9%) individuals with diabetes reported using insulin (data not shown).

Diabetes care in selected regions

Appropriate care is critical to managing diabetes and to preventing serious complications. In 2003, the Canadian Diabetes Association published the Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada.[4] These guidelines

Figure 1
Percentage of Canadians with physician-diagnosed diabetes, by province/ territory, household population aged 12 or older, Canada, 2005



* signficantly different from estimate for Canada ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published (coefficient of variation greater than 33.3%, suppressed because of extreme sampling variability)
Source: 2005 Canadian Community Health Survey.

Table 1
Percentage of Canadians with physician-diagnosed diabetes, by sex and age group, household population aged 12 or older, Canada, 2005

	%
Total	4.9
Males	5.4†
Females	4.4†
Age group	
12 to 17	0.3E
18 to 34	0.9*
35 to 44	2.0*
45 to 64	6.9*
65 or older	14.6*

† significantly different from estimate for total and other sex ($p < 0.05$)
* significantly different from estimate for total and all other age groups ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
Source: 2005 Canadian Community Health Survey.

recommend the type of care that should be provided to individuals with diabetes.

While some information about the quality of care for diabetes in Canada is available,[1,5] it has been based on small studies that do not always represent the overall Canadian population. The 2005 CCHS included a set of questions on diabetes care. Developed by Statistics Canada in collaboration with the Public Health Agency of Canada, these questions were designed to collect information about the care practices of people with diabetes, including glucose testing and foot and eye examinations (see *The data*).

The following information on hemoglobin A1C testing, foot care and eye exams is based on the "diabetes care module" of the 2005 CCHS and reflects results from the following provinces and territories: Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory.

Hemoglobin testing

Management of glycemic levels is a critical part of diabetes care. Glycemic control, as measured by hemoglobin A1C, is associated with a reduced risk of developing long-term complications. The Clinical Practice Guidelines recommend that a physician measure this indicator every three months to ensure that glycemic goals are being met or maintained.

In 2005, almost three-quarters (74%) of diabetic respondents aged 18 or older reported having had their hemoglobin A1C checked by a health care professional at least once in the year before the survey (Table 2). Diabetic respondents who had been tested were tested an average of 3.4 times during the 12-month period, or about once every three and a half months (data not shown). Rates were similar for men and women aged 18 or older, as well as across age groups. Diabetics who used insulin were more likely to have been tested (83%) than those not using insulin (74%).

Among the diabetic population, half (49.8%) reported that they, or a family member had checked their glucose level every day (Table 3).

Foot care

Individuals with diabetes often experience foot problems such as ulcers, lesions and infections. Without appropriate care, these may lead to more serious health conditions such as gangrene and the need for amputation. To reduce the risk of serious complications and to improve quality of life, the Clinical Practice Guidelines recommend annual foot examinations for all people with diabetes, and more frequent exams for those at high risk. The Guidelines also recommend that high-risk individuals receive instruction for appropriate self-care.

In 2005, almost half (48%) of the diabetic population aged 18 or older (in Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory) reported having had their feet checked

Table 2
Percentage of Canadians with physician-diagnosed diabetes reporting tests performed by a health care professional, by selected characteristics, household population aged 18 or older, selected provinces/territories,† 2005

	Hemoglobin A1C test, past 12 months		Foot examination, past 12 months		Eye exam (pupils dilated), ever	
	%	95% confidence interval	%	95% confidence interval	%	95% confidence interval
Total, aged 18 or older	**74.4**	**72.2 to 76.6**	**48.4**	**45.9 to 51.0**	**68.2**	**65.8 to 70.5**
Sex						
Male‡	75.6	72.5 to 78.8	49.1	45.3 to 52.8	67.2	64.0 to 70.5
Female	72.7	69.7 to 75.8	47.5	44.0 to 51.0	69.4	66.3 to 72.6
Age						
18 to 24‡	71.9	65.1 to 78.8	45.9	38.1 to 53.7	58.6	50.5 to 66.7
45 to 64	76.2	72.6 to 79.8	48.5	44.7 to 52.4	70.3*	66.7 to 73.9
65 or older	73.3	70.3 to 76.3	49.0	45.3 to 52.8	68.8*	65.8 to 70.5
Uses insulin						
Yes‡	82.9	78.6 to 87.1	67.8	62.8 to 72.8	81.8	77.5 to 86.0
No	74.1*	71.5 to 76.6	44.7*	41.7 to 47.6	66.3*	63.6 to 69.0
Has a regular medical doctor						
Yes	74.8*	72.5 to 77.1	48.7	46.1 to 51.3	68.5	66.2 to 70.9
No‡	61.5	52.1 to 71.0	39.8	29.6 to 49.9	56.5	45.9 to 67.0
Household income						
Less than $20,000	70.8	66.2 to 75.3	46.1	40.6 to 51.5	65.5	60.8 to 70.3
$20,000 to $39,999	72.7	68.3 to 77.1	52.0	47.3 to 56.6	69.8	65.4 to 74.3
$40,000 to $59,999	76.5	71.1 to 81.9	42.7	36.3 to 49.1	67.8	61.6 to 74.0
$60,000 or more‡	77.8	73.0 to 82.6	52.4	47.0 to 57.8	69.1	63.8 to 74.4
Missing	72.5	67.1 to 77.9	44.4	38.0 to 50.7	66.7	60.6 to 72.8
Highest level of education						
Less than secondary	73.2	69.9 to 76.5	46.0	41.8 to 50.2	65.4	61.6 to 69.1
Secondary graduation‡	75.9	70.0 to 81.7	53.5	46.3 to 60.6	67.3	60.7 to 73.9
Some postsecondary	73.6	65.3 to 81.9	39.0	27.7 to 50.3	72.6	63.7 to 81.5
Postsecondary graduation	76.7	73.1 to 80.3	50.8	47.0 to 54.5	70.8	66.9 to 74.6

† Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory
‡ reference category
* significantly different from estimate for reference category ($p < 0.05$)
Source: 2005 Canadian Community Health Survey, diabetes care module.

Table 3
Diabetes care provided by self, family member or friend, diabetic household population aged 18 or older, selected provinces/territories,† 2005

	Glucose checked (frequency)		Feet checked (frequency)	
	%	95% confidence interval	%	95% confidence interval
Daily	49.8	47.1 to 52.4	37.4	34.9 to 39.9
Weekly	27.9	25.6 to 30.2	17.3	15.3 to 20.9
Monthly	7.2	5.9 to 8.6	6.1	5.0 to 7.2
Yearly	2.9	2.1 to 3.6	3.7	2.9 to 4.5
Never	9.7	8.2 to 11.2	31.3	28.8 to 33.8

† Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory.
Source: 2005 Canadian Community Health Survey, diabetes care module.

by a health care professional at least once during the previous 12 months (Table 3). On average, these individuals had had their feet checked 3.7 times over a 12-month period. The participation rates were similar for males and females, and across age groups and socio-economic status. Individuals using insulin were more likely to have had their feet checked (68%), compared with those who were not using insulin (45%). After adjusting for other factors, diabetic respondents using insulin were 2.7 times more likely to have had their feet examined by a health care professional in the previous year, compared with those not using insulin.

Respondents were also asked about foot care provided by themselves or

The data

Estimates in this article are based on data from the 2005 Canadian Community Health Survey (CCHS), conducted by Statistics Canada. The CCHS covers the population aged 12 or older living in private households. It does not include residents of Indian reserves, institutions, and some remote areas, full-time members of the Canadian Forces, and civilian residents of military bases. The data were collected by personal and telephone interviews between January and December 2005. The estimated prevalence of diabetes is based on these national data for the population aged 12 or older (n=132,947).

In 2005, participation in the "diabetes care module" of the CCHS was optional, and all health regions in Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory chose to participate. Data on individuals aged 18 or older in these provinces were selected for analysis (n=3,924).

Following the collection and processing of the data, the respondents' records were weighted to reflect the sampling and non-response that occurred in the CCHS. Weights were adjusted to demographic projections by age group and province.

Weighted distributions and frequencies were produced. Partial or item non-response accounted for less than 5% of the totals in most analyses; records with item non-responses were excluded from the calculations. The bootstrap technique, which fully adjusts for the design effects of the survey, was used to estimate the variance and confidence intervals; a significance level of $p = 0.05$ was established.

All 2005 Canadian Community Health Survey (CCHS) respondents aged 12 or older were asked a series of questions about "long-term conditions" that were expected to last, or had already lasted, six months or more and that had "been diagnosed by a health care professional." Individuals who reported having received a diagnosis of diabetes were asked several follow-up questions, including their age at diagnosis and whether they were using insulin.

In 2005, all health regions in Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory chose to participate in the diabetes care module of the CCHS. Respondents aged 18 or older were asked:

- "In the past 12 months, has a health care professional tested you for hemoglobin A-one-C? (An A-one-C hemoglobin test measures the average level of blood sugar over a three-month period.)" Those who said "yes" were asked how many times they had had the test.
- "In the past 12 months, has a health care professional checked your feet for any sores or irritations?" People who said "yes" were asked how often they had had such checks.
- "Have you ever had an eye exam where the pupils of your eyes were dilated?" Response categories were: less than one month ago; one month to less than one year ago; one year to less than two years ago; and two or more years ago.

These questions were derived in part from the 2003 Behavioral Risk Factor Surveillance System (BRFSS) in the United States, which has been used for reporting diabetes care indicators since 1984.[6]

The information respondents provided about their diabetic status and health care (professional and self-care) is based on self-reported data, and has not been clinically validated. The CCHS did not ask respondents specifics about their diagnosis (i.e., whether they had Type I (insulin-dependent) or Type II (non-insulin-dependent) diabetes).

a family member or friend. The majority of respondents (65%) indicated that they, or a family member or friend, had checked their feet for sores or irritations at least once in the previous 12 months; 37% checked daily and 17% checked weekly (Table 3). Almost one third of respondents indicated that they had never checked their feet.

Eye exams

People with diabetes are at risk of developing diabetic retinopathy—a disease of the blood vessels of the eye. High blood sugar levels cause the blood vessels in the eye to weaken and leak tiny amounts of blood or fluid, causing swelling of the retina. Vision may become blurred and, in some cases, blindness will result. The Clinical Practice Guidelines recommend that all people with diabetes be screened and examined for retinopathy when diabetes is first diagnosed.

Most of those responding to the questions on diabetes care (68%) indicated that, at least once, they had had an eye test where their pupils were dilated. Diabetics aged 18 to 44 were less likely to have had a dilation eye exam in the past 12 months, compared with older diabetic respondents (Table 2). As with other types of care, those using insulin were more likely to have had an eye exam (82%), compared with those not using insulin (66%). After adjusting for other factors, diabetic respondents taking insulin were 2.7 times more likely to have received an eye dilation examination compared with those not taking insulin.

Among all those who reported having had an eye examination, 14% reported having had it within the last month, 58% between one month and one year ago; and 17%, one to two years ago (Table 4).

Table 4
Most recent eye exam (pupils-dilated), diabetic population aged 18 or older who have ever had a dilation eye exam, selected provinces/territories,† 2005

	%	95% confidence interval
Less than month ago	13.5	11.4 to 15.5
1 month to less than 1 year ago	57.8	54.8 to 60.9
1 year to less than 2 years ago	17.1	14.6 to 19.6
2 or more years ago	11.3	9.3 to 13.4

† Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba and Yukon Territory
Source: 2005 Canadian Community Health Survey, diabetes care module.

Meeting the CPG requirements?

Information from the 2005 CCHS diabetes care module provides insight into care practices for and of diabetic patients in the participating regions of Canada. Overall, the proportion of diabetic respondents meeting the Clinical Practice Guidelines varied by the type of care. Most diabetic patients (74%) had had their hemoglobin A1C checked by a health care professional at least once in the year before the survey, and, on average, those who had received the test were close to meeting the recommended frequency of every three months. The majority of diabetic respondents were also meeting the recommendation for eye examinations (dilation of pupils), but only half had the recommended annual foot examinations. The Canadian rates for eye examinations were slightly higher than those reported in the United States; in 2001, only 66% of the US respondents indicated that they had had an eye examination.[7] For foot examinations, though, the Canadian rates were lower than those in the United States, where approximately 60% of diabetics received annual foot examinations.

The results indicate that diabetics who were using insulin were more likely to receive diabetes care, compared with those not using insulin. In some cases, insulin use may be a marker for a more progressed or advanced disease or may reflect poor glycemic control.

Based on data from six of the provinces/territories, this article presents a first look at the health care practices for diabetics—information needed to better understand this aspect of the disease and the factors that affect the receipt of appropriate care. ■

An electronic version of this article entitled "Diabetes care" was released on June 13, 2006 in the online publication Smoking and Diabetes Care: Results from the CCHS Cycle 3.1, 2005, part of the Your Community, Your Health: Findings from the Canadian Community Health Survey (CCHS) series. *The free publication (Catalogue no. 82-621-XWE2006002) is available at http://www.statcan.ca/bsolc/english/bsolc?catno=82-621-X20060029226.*

References

1. Murphy K, Connor Gorber S, O'Dwyer A. *Health State Descriptions for Canadians: Diabetes* (Statistics Canada, Catalogue 82-619-MIE, no. 002) Ottawa: Minister of Industry, 2005.
2. Public Health Agency of Canada. *Diabetes: What are the Complications of Diabetes?* Available at www.phac-aspc.gc.ca/ccdpc-cpcmc/diabetes-diabete/english/whatis/complications.html. Accessed May 23, 2006.
3. Health Canada. *Responding to the Challenges of Diabetes in Canada: First Report of the National Diabetes Surveillance System 2003.* Available at http://www.ndss.ca. Accessed May 23, 2006.
4. Canadian Diabetes Association. 2003 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes* 2003; 27: Supplement 2.
5. Public Health Agency of Canada. *Diabetes: Facts and Figures.* Available at www.phac-aspc.gc.ca/ccdpc-cpcmc/diabetes-diabete/english/facts/index.html. Accessed May 23, 2006.
6. *Behavioural Risk Factor Surveillance System (BRFSS), State Quesionnaire.* US Government, 2003.
7. Centers for Disease Control and Prevention. Preventive-care practices among persons with diabetes: United States, 1995 and 2001. *Morbidity and Mortality Weekly Report* 2002; 51(43): 965-9.

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Organized extracurricular activities of Canadian children and youth

by Anne Guèvremont, Leanne Findlay and Dafna Kohen

Abstract

This article presents rates of participation in organized extracurricular activity by Canadian children and youth aged 6 to 17 years, and examines how these rates vary by socio-demographic and socio-economic characteristics. The data are from Cycle 4 of the National Longitudinal Survey of Children and Youth (2000/2001). The majority of children and youth (86%) participated in at least one extracurricular activity. Girls were more likely than boys to be involved in non-sport activities and in clubs or community groups. Young children who lived in urban areas and those who lived with two parents had relatively high rates of participation in extracurricular activities. Participation rose with family income for children aged 6 to 13, but not for 14- to 17-year-olds. Children of all ages in the Western provinces had high participation rates in each type of activity; rates tended to be low in Quebec.

Keywords

adolescents, child development, extracurricular activities, sports

Authors

Anne Guèvremont (613-957-4564; anne.guevremont@hrsdc-rhdsc.gc.ca) conducted this research while with the Health Information and Research Division at Statistics Canada; Leanne Findlay (613-951-4648; Leanne.Findlay@statcan.gc.ca) and Dafna Kohen (613-951-3346; Dafna.Kohen@statcan.gc.ca) are with the Health Information and Research Division at Statistics Canada in Ottawa, Ontario, K1A 0T6.

Children's participation in organized extracurricular activities has been associated with positive short- and long-term outcomes, such as academic achievement and prosocial behaviours, and with reduced negative outcomes, such as dropping out of school and emotional and behavioural disorders.[1-4]

The likelihood that children will take part in organized extracurricular activities varies by factors such as their age and gender, family income, and family structure (one- or two-parent family).[3,5,6] Older children, children from higher-income families, and those living with two parents have been shown to have higher participation rates. However, much of this research was conducted in the United States; the most recent Canadian study was based on 1994/1995 data and covered only 6- to 11-year-olds.[3]

This article presents data for 6- to 17-year-olds from the 2000/2001 National Longitudinal Survey of Children and Youth (NLSCY). Rates of participation in sports, non-sport activities, and clubs or community groups are examined, along with how these rates vary by socio-demographic characteristics such as gender and family income (see *The data*).

Majority participate

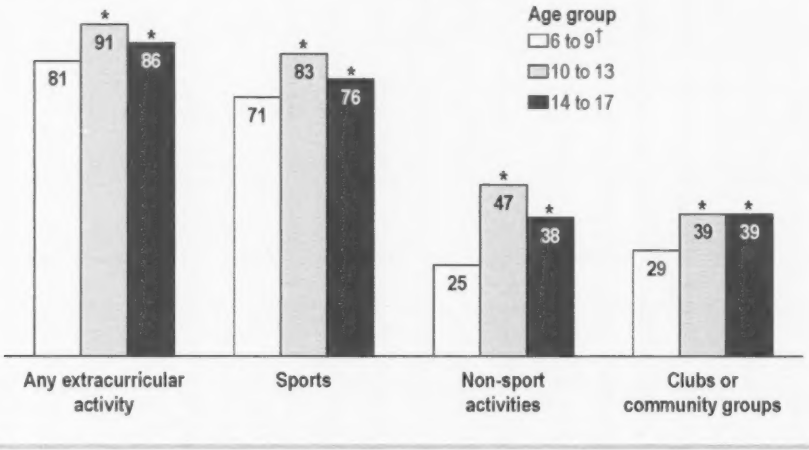
In 2000/2001, a large majority (86%) of Canadian children and teens were reported to have taken part in at least one organized extracurricular activity during the previous year (Figure 1). Participation rates were significantly higher at ages 10 to 13 (91%) and 14 to 17 (86%) than at ages 6 to 9 (81%). A considerably larger proportion of children and youth participated in organized sports than in non-sport activities and in clubs or community groups.

Gender

Overall, boys and girls were equally likely to have taken part in at least one organized extracurricular activity (86% of girls and 85% of boys). However, participation rates in the various types of activity differed by gender.

At ages 6 to 9, boys were more likely than girls to play organized sports, but at older ages, participation rates in sports did not differ significantly by gender

Figure 1
Percentage who participated in organized extracurricular activity, by age group and type of activity, household population aged 6 to 17, Canada, 2000/2001



† reference category
* significantly different from estimate for reference category ($p < 0.05$)
Source: National Longitudinal Survey of Children and Youth, 2000/2001.

(Table 1). At all ages, a larger proportion of girls than boys were involved in non-sport activities and in clubs or community groups.

Living with one or two parents

Family structure was associated with playing organized sports at ages 6 to 9 and 14 to 17. Nearly three-quarters (74%) of 6- to 9-year-olds who lived with two parents played sports, compared with 58% of those living with one parent. At ages 14 to 17, the corresponding figures were 78% and 69%.

By contrast, family structure was not significantly related to children's and teens' involvement in non-sport activities and in clubs or community groups.

The data

The data are from the National Longitudinal Survey of Children and Youth (NLSCY), a comprehensive survey of Canadian children's development and factors that have an impact on their well-being.[7] Cycle 4, which was conducted in the fall of 2000 and in the spring of 2001, was selected for this analysis because it is the most recent NLSCY cycle that provides nationally representative, cross-sectional data for a sample of children aged 6 to 17, including information on a variety of socio-demographic and socio-economic characteristics of the family and children's participation in various activities. This analysis pertains to 5,242 children aged 6 to 9 (representing 1,495,358 children) and 6,926 children and teens aged 10 to 17 (representing 2,889,183 youth).

Information about participation in organized extracurricular activities was reported by parents for 6- to 9-year-olds, and self-reported by 10- to 17-year-olds. Youth not attending school at the time of the survey (about 10% of 16- and 17-year-olds) and children not yet in school (3% of 6- to 9-year-olds) were excluded from this analysis because they had more disposable time and would not be comparable.

Most NLSCY questions about the frequency of participation in various activities referred to the previous 12 months. The exception was questions asked of 14- to 17- year-olds about school-related activities, which concerned the last 3 months. Response categories for parents of 6- to 9-year-olds were: "almost never," "about once a month," "about once a week," "a few times a week," and "most days." Response categories for 10- to 17-year-olds were: "never," "less than once a week," "1 to 3 times a week," and "4 or more times a week." Responses of "almost never" and "never" were categorized as non-participation; all other responses were categorized as participation in an extracurricular activity.

Three types of organized activity were examined: sports, non-sport activities, and clubs or community groups. Two questions were asked about sports: participation in sports with a coach or instructor, and participation or instruction in other physical activities such as dance, gymnastics and martial arts with a coach or instructor. These activities were aggregated into a single variable, *organized sports*. *Non-sport activities* include lessons (other than in class) in music, art, drama, etc. *Clubs or community groups* refer to associations such as Brownies, Guides, Cubs, Scouts, church groups, and 4-H. Youth aged 14 to 17 were asked about participation in both school-related (but out of class) activities such as yearbook club, photography club and student council, and in out-of-school activities. The Appendix contains the full wording of the questions.

The socio-demographic and socio-economic factors examined in relation to extracurricular activities were: age, gender, region (the eastern provinces of Newfoundland and Labrador, New Brunswick, Nova Scotia and Prince Edward Island; Quebec; Ontario; and the Western provinces of British Columbia, Alberta, Saskatchewan, and Manitoba), urban or rural residence (urban areas were defined as areas with a population of at least 1,000 and a minimum of 400 people per square kilometre), whether the child lived with one or two parents, and the ratio of family income to the low income cut-off (LICO). The LICO is a statistical measure of the income thresholds below which families likely devote a larger-than-average share of their income to the necessities of food, shelter and clothing.[8] To reflect differences in costs for different community and family sizes, LICOs are defined for five community size categories and seven family size categories.

Participation rates by socio-demographic characteristics were tested for statistical differences with t-tests. All analyses were weighted using a normalized population weight, and variance estimation used the bootstrap technique to account for the complex survey design.[9-11]

Table 1
Percentage who participated in organized extracurricular activity, by age group, type of activity and selected characteristics, household population aged 6 to 17, Canada, 2000/2001

	Any extra-curricular activity	Type of activity		
		Sports	Non-sport actvities	Clubs or community groups
Total	**85.5**	**76.4**	**35.7**	**35.0**
Age				
6 to 9†	80.9	70.7	24.8	29.1
10 to 13	90.9*	83.5*	46.9*	38.8*
14 to 17	85.8*	76.2*	38.0*	38.6*
Gender				
Age 6 to 9				
Male†	82.4	73.9	20.4	25.6
Female	79.3	67.5*	29.3*	32.7*
Age 10 to 13				
Male†	89.1	81.5	39.5	31.7
Female	92.7*	85.4	54.3*	45.8*
Age 14 to 17				
Male†	84.9	77.8	27.8	30.1
Female	86.7	74.6	48.2*	46.9*
Family structure				
Age 6 to 9				
One parent	71.9*	58.3*	20.5	25.4
Two parents†	82.9	73.6	25.8	30.0
Age 10 to 13				
One parent	89.6	82.3	48.5	34.7
Two parents†	91.2	83.7	46.7	39.7
Age 14 to 17				
One parent	79.9*	69.2*	32.1	33.1
Two parents†	87.4	78.2	39.5	40.0
Family income				
Age 6 to 9				
Below LICO†	64.4	48.7	17.8	22.0
One to less than two times LICO	78.5*	66.1*	22.2	27.5
Two to less than three times LICO	88.2*	82.3*	25.7*	30.5
Three or more times LICO	93.6*	87.9*	36.4*	36.9*
Age 10 to 13				
Below LICO†	82.8E	71.8	38.0	38.5
One to less than two times LICO	90.5*	82.4*	46.5	39.8
Two to less than three times LICO	91.6*	84.4*	46.1	39.0
Three or more times LICO	96.5*	92.1*	54.8*	37.7
Age 14 to 17				
Below LICO†	82.9	72.5	32.1	40.3
One to less than two times LICO	80.8	71.1	32.6	37.5
Two to less than three times LICO	89.6	78.6	39.6	37.9
Three or more times LICO	89.1	81.7	44.6*	39.9
Area of residence				
Age 6 to 9				
Urban	81.4*	71.5*	25.7*	29.0
Rural†	77.0	65.4	18.5	29.9
Age 10 to 13				
Urban	90.7	83.5	46.8	38.4
Rural†	91.8	83.0	47.7	40.9
Age 14 to 17				
Urban	86.4	77.2*	38.1	39.1
Rural†	82.3	70.1	37.4	35.2
Region				
Age 6 to 9				
East	80.1	62.9	22.8	48.0*
Quebec	73.0*	65.0	17.9*	x
Ontario	83.3	72.9	27.2	32.9
West†	83.8	74.1	27.2	35.3
Age 10 to 13				
East	93.8	84.0	52.6	51.1
Quebec	88.4*	81.2	36.1*	23.2*
Ontario	89.8	83.4	48.6	41.3
West†	93.9	85.6	53.2	46.7
Age 14 to 17				
East	83.5*	73.4*	39.9	43.3
Quebec	78.4*	72.2*	30.2*	26.6*
Ontario	86.4*	75.6	35.6*	37.6*
West†	90.9	80.7	46.4	47.1

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
x suppressed to meet the confidentiality requirements of the Statistics Act
Source: National Longitudinal Survey of Children and Youth, 2000/2001.

Family income

Participation in organized extracurricular activities varied by family income, especially for young children (Figure 2). At ages 6 to 9, an income gradient in participation rates was evident for each type of activity. For example, 88% of 6- to 9-year-olds from the highest income families had participated in organized sports the previous year, compared with 49% of those from the lowest income families.

Sports participation also varied by family income for 10- to 13-year-olds: over 92% of those from the highest income families had played organized sports, compared with 72% from the lowest income families.

Among 14- to 17-year-olds, those from the highest income families were more likely to take part in non-sport activities than were youth from the lowest income families, but participation in sports and in clubs or community groups did not vary by family income.

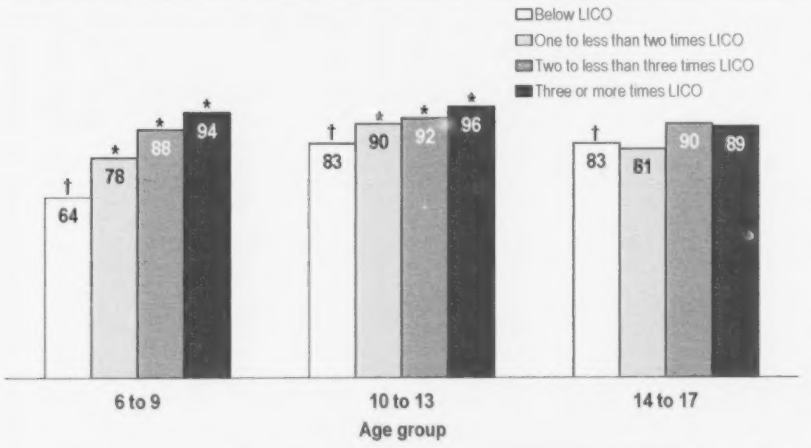
Urban/Rural residence

Urban versus rural residence was related to the extracurricular activities of the youngest children, but the association diminished at older ages. Children aged 6 to 9 in urban areas were generally more likely than those in rural areas to participate in organized sports and in non-sport activities. As well, urban youth aged 14 to 17 were significantly more likely than those in rural areas to play organized sports. Urban versus rural residence was not significantly associated with the extracurricular activities of children aged 10 to 13.

Region

Participation in organized extracurricular activities tended to be low for children and teens in Quebec, compared with those in the Western provinces. Relatively small proportions of Quebec children aged 6 to 9 and 10 to 13 took part in non-sport activities. And for Quebec youths aged 14 to 17,

Figure 2
Percentage who participated in at least one extracurricular activity, by age group and ratio of family income to low-income cutoff (LICO), household population aged 6 to 17, Canada, 2000/2001



† reference category
* significantly different from estimate for reference category ($p < 0.05$)
Source: National Longitudinal Survey of Children and Youth, 2000/2001

participation rates were low not only in non-sport activities and in clubs or community groups, but also in sports.

As well, 14- to 17-year-olds in the Eastern provinces were significantly less likely than those in the Western provinces to play organized sports. In Ontario, youth of these ages were less likely to participate in non-sport activities and in clubs or community groups.

Conclusion

In 2000/2001, a large majority of Canadian children and youth were reported to have taken part in at least one organized extracurricular activity during the previous year. However, differences by socio-demographic and socio-economic characteristics were apparent. The likelihood of involvement in extracurricular activities was associated with age, family structure, family income, urban versus rural residence, and region. ■

References

1. Cooper H, Valentine JC, Nye B, Lindsay JJ. Relationships between five after-school activities and academic achievement. *Journal of Educational Psychology* 1999; 91: 369-78.
2. Mahoney JL, Cairns RB. Do extracurricular activities protect against early school dropout? *Developmental Psychology* 1997; 32: 241-53.
3. Offord DR, Lipman EL, Duku EK. *Sports, the Arts, and Community Programs: Rates and Correlates of Participation*. Ottawa, Ontario: Human Resources and Social Development Canada, 1998.
4. Zaff JS, Moore KA, Papillo AR, Williams S. Implications of extracurricular activity participation during adolescence on positive outcomes. *Journal of Adolescent Research* 2003; 18: 599-630.
5. Eccles JS, Barber B. Student council, volunteering, basketball, or marching band: What kinds of extracurricular involvement matters? *Journal of Adolescent Research* 1999; 14: 10-43.
6. Harrison PA, Narayan G. Differences in behavior, psychological factors, and environmental factors associated with participation in school sports and other activities in adolescence. *The Journal of School Health* 2003; 73: 113-9.
7. Statistics Canada, Human Resources Development Canada. *National Longitudinal Survey of Children and Youth, Cycle 4, Survey Instruments 2000-01: Book 1 - Parent, Child, and Youth*. Ottawa, Ontario: Statistics Canada, 2001.
8. Statistics Canada. *Low Income Cutoffs from 1994 - 2003 and Low Income Measures from 1992 - 2001*. Ottawa, Ontario: Minister of Industry, 2004.
9. Rao JNK, Wu CFJ, Yue K. Some recent work on resampling methods for complex surveys. *Survey Methodology* (Statistics Canada, Catalogue 12-000) 1992; 18(2): 209-17.
10. Rust KF, Rao JNK. Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research* 1996; 5: 281-310.
11. Yeo D, Mantel H, Liu TP. Bootstrap variance estimation for the National Population Health Survey. Baltimore: American Statistical Association, 1999.

Appendix

National Longitudinal Survey of Children and Youth (2000/2001) questions about extracurricular activities

Sports

Ages 6 to 9
- In the last 12 months, out of school hours, how often has your child: taken part in sports with a coach or instructor (except dance or gymnastics)?
- In the last 12 months, outside of school hours, how often has your child: taken lessons or instruction in other organized physical activities with a coach or instructor such as dance, gymnastics or martial arts?

Ages 10 to 13
- During the past 12 months, how often have you played sports WITH a coach or instructor (swimming lessons, baseball, hockey, etc.)?
- During the past 12 months, how often have you taken part in dance, gymnastics, karate or other groups or lessons, other than in gym class?

Ages 14 to 15
- In the last 3 months, how often have you taken part in the following school-based activities (other than in class): Played sports WITH a coach or an instructor other than for gym class (e.g., school teams)?
- In the last 3 months, how often have you taken part in the following school-based activities (other than in class): Taken part in dance, gymnastics, karate or other groups or lessons, other than in gym class?
- Out of school, during the past 12 months, how often have you played sports WITH a coach or instructor (swimming lessons, baseball, hockey, etc.)?
- Outside of school, during the past 12 months, how often have you taken part in dance, gymnastics, karate or other groups or lessons (always organized outside of school)?

Ages 16 to 17
- In the last 3 months, how often have you taken part in the following activities in school (other than in class): Played sports WITH a coach or an instructor, other than in gym class (e.g., school teams)?
- In the last 3 months, how often have you taken part in the following activities in school (other than in class): Taken part in dance, gymnastics, karate or other groups or lessons other than in gym class?
- Out of school, in the last 12 months, how often have you: Played sports or done physical activities with a coach or instructor (e.g. swimming lessons, baseball, hockey, aerobics, etc.)?
- Outside of school, in the last 12 months, how often have you: Taken part in dance, gymnastics, karate or other groups or lessons (outside of school)?

Non-sport activities

Ages 6 to 9
- In the last 12 months, out of school hours, how often has your child: taken lessons or instruction in music, art or other non-sport activities?

Ages 10 to 13
- During the past 12 months, how often have you taken part in art, drama or music groups, clubs or lessons outside of class?

Ages 14 to 15
- In the last 3 months, how often have you taken part in the following school-based activities (other than in class): Taken part in art, drama or music groups, clubs or lessons, outside of class?
- Out of school, during the past 12 months, how often have you taken part in art, drama or music groups, clubs or lessons(again out of school)?

Ages 16 to 17
- In the last 3 months, how often have you taken part in the following activities in school (other than in class): Taken part in art, drama or music groups, clubs or lessons outside of class?
- Out of school, in the last 12 months, how often have you: Taken part in art, drama or music groups, clubs or lessons (out of school)?

Clubs or community groups

Ages 6 to 9
- In the last 12 months, out of school hours, how often has your child: taken part in any clubs, groups or community programs with leadership, such as Brownies, Cubs or church groups?

Ages 10 to 13
- In the last 12 months, how often have you taken part in clubs or groups such as Guides or Scouts, 4-H club, community, church or other religious groups?

Ages 14 to 15
- In the last 3 months, how often have you taken part in the following school-based activities (other than in class): Taken part in a school club or group such as yearbook club, photography club or student council?
- Out of school, during the past 12 months, how often have you taken part in clubs or groups such as Guides or Scouts, 4-H club, community, church or other religious groups?

Ages 16 to 17
- In the last 3 months, how often have you taken part in the following activities in school (other than in class): Taken part in a school club or group such as student council, yearbook club or photography club?
- Out of school, in the last 12 months, how often have you: Taken part in clubs or groups such as Guides or Scouts, Junior Farmers, community, political, church or other religious groups?

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

The feasibility of establishing correction factors to adjust self-reported estimates of obesity

by Sarah Connor Gorber, Margot Shields, Mark S. Tremblay and Ian McDowell

Abstract

Background

This study examines the feasibility of developing correction factors to adjust self-reported measures of body mass index (BMI) to more closely approximate measured values.

Data and methods

Data are from the 2005 Canadian Community Health Survey (subsample 2), in which respondents were asked to report their height and weight, and were subsequently measured. Regression analyses were used to determine which socio-demographic and health characteristics were associated with the discrepancies between self-reported and measured values. The sample was then split into two groups. In the first, self-reported BMI and the predictors of the discrepancies were regressed on measured BMI. Correction equations were generated using all predictor variables that were significant at the $p<0.05$ level. These correction equations were then tested in the second group to derive estimates of sensitivity, specificity and obesity prevalence. Logistic regression was used to examine relationships between self-reported, measured and corrected BMI and obesity-related health conditions.

Results

Corrected estimates provide more accurate measures of obesity prevalence, mean BMI and sensitivity levels (percentage correctly classified). In almost all cases, associations between BMI and health conditions are more accurate when based on corrected versus self-reported values.

Keywords

Bias, body mass index, direct measure, measurement error, obesity, overweight, prevalence, self-report

Authors

Sarah Connor Gorber (613-951-1193; Sarah.ConnorGorber@statcan.gc.ca) and Margot Shields (613-951-4177; Margot.Shields@statcan.gc.ca) are with the Health Information and Research Division at Statistics Canada, Ottawa, Ontario, K1A 0T6. Mark S. Tremblay is with the Children's Hospital of Eastern Ontario Research Institute. Ian McDowell is with the Department of Epidemiology and Community Medicine, University of Ottawa.

Obesity is a public health problem in both the developed and developing world. Globally, an estimated 400 million people are obese.[1] In Canada, the prevalence is estimated to be 23% in adults[2] and 8% in children,[3] with rates expected to rise in coming years.[4,5] The costs associated with obesity represent approximately 2% of Canada's total health care expenditures.[6]

Because collecting measured data is expensive, national estimates of the prevalence of obesity are usually based on self-reported survey data. In most countries, body mass index (BMI) is used to estimate the prevalence of obesity because BMI can be easily calculated from self-reported height and weight. However, in both clinical and population samples, self-reports have tended to overestimate height and underestimate weight, which results in a systematic underestimation of obesity prevalence.[7-10] This tendency has recently been confirmed in a review of 64 international studies,[11] as well as in Canadian research.[12]

Underestimating the prevalence of obesity is important not only because obesity itself can cause social and physical impairment, but also because it is a risk factor for disease.[13-15] When estimates of obesity are based on self-reported data, the relationship between obesity and conditions such as diabetes, hypercholesterolemia, hypertension, arthritis and heart disease is substantially exaggerated.[16-18]

Given that much population health surveillance will continue to rely on self-reported data, it has been suggested[19] that estimates of obesity based on self-reports could be adjusted to more closely approximate measured values. Using data from the 2005 Canadian Community Health Survey (CCHS), which collected both self-reported and measured height and weight, this study examines the feasibility of developing correction equations to adjust self-reported estimates, and assesses whether these equations improve the estimation of obesity (when based on BMI).

Methods

Data source

Data for this study come from the 2005 CCHS. The CCHS is an ongoing survey designed to provide timely cross-sectional estimates of health determinants, health status and health system use at a sub-provincial level.[20] Sampling is based on a multi-stage cluster sampling technique that is representative of over 98% of the Canadian population (members of the Canadian Forces, individuals living on Indian Reserves or Crown lands, and residents of institutions, Canadian Forces bases and certain remote regions are excluded). Three sampling frames were used to select households for the 2005 survey: 49% of the sample of households came from an area frame; 50% from a list frame of telephone numbers; and the remaining 1% from a Random Digit Dialing (RDD) sampling frame. More details about the CCHS are available in Béland, 2002.[21]

The 2005 CCHS collected data from 132,947 respondents, yielding a response rate of 79%. A subsample of 7,376 respondents aged 12 years or older were asked their height and weight, and later in the interview, were directly measured. These respondents were all drawn from the area frame and were selected across the ten provinces in proportion to their populations (residents of the territories were excluded). Measured height and weight were obtained for 4,735 individuals—a response rate of 64%. (The main reason for non-response was refusal.)

Because of the high non-response to measured height and weight, an adjustment was made to minimize non-response bias. A special sampling weight was created by redistributing the sampling weights of non-respondents to respondents using response propensity classes. The variables used to create these classes were region (British Columbia, Prairies, Ontario, Quebec, Atlantic provinces), age, sex, household size, marital status, rural/urban indicator, and quarter of data collection.

The present study included only adults aged 18 years or older. Children are in a stage of development where weight and height may change over short periods of time. It has also been suggested that the nature of the reporting error in children and adolescents may differ from that in adults.[10] Women who were pregnant (n=47) or breastfeeding (n=58) were also excluded, as BMI is not recommended for use in these groups. Respondents for whom the difference between self-reported and measured estimates of height, weight or BMI were more than 3 standard deviations from the mean were considered outliers and were excluded from the analysis (n=43, n=44 and n=39, respectively). This left 4,080 respondents with self-reported and measured values for height and weight.

CCHS interviewers were trained to measure height and weight. Height was measured to the nearest 0.5 cm (without shoes) with a measuring tape attached to the wall. Weight was measured to the nearest 0.1 kg (without shoes) with a calibrated digital scale (ProFit UC-321 made by Lifesource). The interview lasted approximately 50 minutes and took place in the respondent's home. Self-reported height and weight were collected near the beginning of the interview; the measurements were taken near the end. Respondents were not told that they would be measured.

Self-reported height and weight were collected with the questions: "How tall are you without shoes on?" and "How much do you weigh?" Categories for height in feet and inches were listed on the questionnaire with corresponding metric values in brackets. Interviewers rounded up to the closest inch for respondents who reported half-inch measures. If questioned, interviewers told respondents to report their weight without clothing. Respondents were asked if they had reported in pounds or kilograms; 94% reported in pounds.

Analytical techniques

The first step was to use the full subsample (n=4,080) to determine which factors were associated with the bias between self-reported and measured height and weight. The bias was calculated by subtracting the measured value from the self-reported value. Negative values indicated underestimation; positive values, overestimation.

Multiple linear regression was used with the bias as the dependent variable in the model. Socio-demographic and health variables, selected based on a review of the literature, were entered as independent variables. Separate models were estimated with the bias in weight, height and BMI as dependent variables. All models were estimated separately for men and women, because the bias differs between the sexes.[8,22-24] Variables that were significant ($p<0.05$) were used to develop the correction equations.

The sample was then randomly divided into two parts: split-sample A and split-sample B, each containing approximately 50% of the respondents (2,029 or 49.7% and 2,051 or 50.3%, respectively). Split-sample A was used to generate the correction equations using the variables that were significantly associated with the bias in height, weight and BMI identified in the first step. Split-sample B was used to test the equations. To generate the correction equations, the measured value was the dependent variable, and the self-reported value and any variables that were significantly associated with the bias from the first part of the study were independent variables. Only significant independent variables (or categorical variables for which at least one category was significant) were retained for the final correction equations.

Four models were tested: two Full Models and two Reduced Models. In Model 1 (the first Full Model), estimates of height and weight were first adjusted based on the predictors that were

significantly related to the bias in height and weight, respectively, in step 1. BMI was then calculated using the adjusted values of height and weight. In Model 2 (the second Full Model), BMI was adjusted by regressing the predictors of the bias in BMI from step 1 directly onto measured BMI. The Reduced Models were similar, except only self-reported height, weight and BMI were used as independent predictors of the measured values. The models are shown in Table 1.

All analyses were run for men and women separately. Interactions and quadratic terms were tested as appropriate. All variables were entered into the models simultaneously, but only significant variables were retained to generate the final correction equations. Final models were tested to ensure they met the assumptions of independence, linearity, equal variance, and normality.

The correction equations generated from split-sample A were applied to the data in split-sample B. Descriptive statistics (means, prevalence of selected categories) were used to compare the self-reported, measured and corrected estimates of obesity. Sensitivity (proportion of obese, overweight or normal weight respondents, based on measured values, who were classified as obese based on self-reported and corrected estimates) and specificity (proportion of non-obese, non-overweight or non-normal weight respondents who were correctly classified based on self-reported and corrected estimates) were used to determine if the corrected estimates improved BMI classification, compared with self-reported estimates. According to the World Health Organization[25] and Canadian classification guidelines,[26] respondents were categorized as underweight (BMI less than 18.5 kg/m^2), normal weight (BMI 18.5 to 24.9 kg/m^2), overweight (BMI 25.0 to 29.9 kg/m^2) or obese (BMI 30.0 kg/m^2 or more).

Logistic regression was then used to determine if the corrected estimates more accurately modeled the relationship between obesity and obesity-related health conditions than did the self-reported estimates. All models controlled for age and sex and examined the relationship between BMI (self-reported, measured and corrected) and one of six conditions: diabetes, heart disease, hypertension, arthritis, activity limitations, and fair or poor self-rated health. The analysis was restricted to respondents aged 40 years or older, because the six conditions are more prevalent in that age range.

Data were appropriately weighted, and all measures of variance were estimated with the bootstrap technique to account for the complex survey design.[27-28] SAS (version 9.1) was used for all analyses.

Table 1
Correction equations to adjust self-reported estimates of weight, height and body mass index (BMI), Full and Reduced Models

	Equation
Full Models	
Model 1 (Height and Weight)	$Weight_{measured}=b_0+b_1(weight_{self\text{-}reported})+b_2(var1)+b_3(var2)+b_i(x_i)\ldots+error$ $Height_{measured}=b_0+b_1(height_{self\text{-}reported})+b_2(var1)+b_3(var2)+b_i(x_i)\ldots+error$
Model 2 (BMI)	$BMI_{measured}=b_0+b_1(bmi_{self\text{-}reported})+b_2(var1)+b_3(var2)+b_i(x_i)\ldots+error$
Reduced Models	
Model 3 (Height and Weight)	$Weight_{measured}=b_0+b_1(weight_{self\text{-}reported})+error$ $Height_{measured}=b_0+b_1(height_{self\text{-}reported})+error$
Model 4 (BMI)	$BMI_{measured}=b_0+b_1(bmi_{self\text{-}reported})+error$

Definitions

The socio-demographic variables included *age* (divided into seven groups: 18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 65 to 74, and 75 years or older); *level of education* (less than secondary graduation, secondary graduation, some postsecondary, and postsecondary graduation); *geographic region* (Atlantic, Québec, Ontario, West and British Columbia); *urban or rural area*; *employment status* the week before the interview (full-time, part-time or not working); *immigrant status* (10 or fewer years in Canada, more than 10 years in Canada and Canadian-born); *ethnicity* (collapsed because of sample size into White, East and South East Asian, and Other); and *household income*. Household income groups were derived by dividing total household income from all sources in the previous 12 months by Statistics Canada's low-income cutoff (LICO) specific to the number of people in the household, the size of the community, and the survey year. These adjusted income quotients were grouped into deciles.

The health variables were self-reported *health status* and *mental health status* (dichotomized into fair/poor versus good/very good/excellent); *activity limitations* imposed by a long-term health problem (sometimes/often versus never); *smoking status* (daily/occasional versus non-smoker); *self-perceived stress* (most days are quite a bit/extremely stressful versus a bit/not very stressful); *life satisfaction* (dissatisfied/very dissatisfied versus satisfied/very satisfied); *perception of weight* (overweight, underweight, or about right); *number of physician consultations in the past year* (continuous); and *chronic conditions* (asthma, arthritis/rheumatism, hypertension, diabetes, heart disease, cancer, mood disorders). Sample sizes were too small to examine associations with eating disorders.

Leisure-time physical activity level was based on total energy expenditure (EE) during leisure time. EE was

calculated from the reported frequency and duration of all of a respondent's leisure-time physical activities in the three months before the 2005 CCHS interview and the metabolic energy demand (MET value) of each activity, which was independently established.[29]

$EE = \Sigma(N_i * D_i * MET_i / 365 \text{ days})$, where

N_i = number of occasions of activity i in a year,

D_i = average duration in hours of activity i, and

MET_i = a constant value for the metabolic energy cost of activity i.

An EE of 3 or more kilocalories per kilogram per day (KKD) was defined as *active*; 1.5 to 2.9 KKD, *moderately active*; and less than 1.5 KKD, *inactive*.

The influence of *end-digit preference* (the tendency to round responses to numbers ending in 0 and 5) was examined for weight, because past research has associated it with a reporting bias.[8,10,30] The majority of CCHS respondents (73% of men and 67% of women) reported values for their weight that ended in 0 or 5, although it would be expected that, by chance, only about 20% of respondents would have end-digits of 0 or 5.

Results

Consistent with past research, mean values of self-reported height were *over*estimated, while weight and BMI were *under*estimated. Men *over*estimated their height by 1.08 cm, and *under*estimated their weight by 1.84 kg and hence, their calculated BMI by 0.94 kg/m^2. For women, height was *over*estimated by 0.56 cm, and weight and BMI were *under*estimated by 2.47 kg and 1.19 kg/m^2, respectively.

The regression results derived from split-sample A that were used to establish the correction equations for *weight* are shown in Table 2. In the Full Models for men, self-reported weight, age and the respondents' perception of being over- or underweight were significant predictors of measured weight. Those who perceived themselves as overweight tended to underestimate their weight, and those who perceived themselves as underweight tended to overestimate their weight; the model adjusted these values up or down as appropriate. The adjusted R^2 was .95 for both the Full and Reduced Models.

For women, factors associated with measured weight were self-reported weight, the perception of being overweight, and end-digit preference (the model added a positive adjustment to self-reported weight to compensate for this tendency). The adjusted R^2 for women for both the Full and Reduced Models was .97.

Results for *height* are found in Table 3. Among men, self-reported height, age and life dissatisfaction were significant predictors of measured height, with a negative adjustment related to age and a positive adjustment for those who reported being dissatisfied with their lives. The adjusted R^2 was .82 for the Full Model and .81 for the Reduced Model. For women, all age groups were significantly associated with measured height except for 45 to 54 years. Also significant were those whose ethnicity was a group other than White or East/South East Asian, and those who reported an activity limitation.

For *BMI* (Table 4), the Full Models adjusted self-reported estimates down for men who were dissatisfied with life and who perceived themselves as underweight, and positive adjustments were made for age. For women, significant predictors of measured BMI were self-reported BMI, education, perception of being overweight, and end-digit preference. The R^2 was higher for the female than the male models, but in both cases, was similar for the Full and Reduced Models.

Table 2
Regression results for establishing correction equations for weight, by sex, Full and Reduced Models generated from split-sample A, household population aged 18 years or older, 2005

	Variable	Coefficient	95% confidence interval
Men			
Full Model	Intercept	-0.30	-2.7 to 2.1
R^2= 0.95	Self-reported weight (kilograms)	1.01*	1.0 to 1.0
R^2(adj)= 0.95	Aged 25 to 34 years†	0.54	-0.5 to 1.6
	Aged 35 to 44 years†	0.39	-0.7 to 1.5
	Aged 45 to 54 years†	0.50	-0.5 to 1.5
	Aged 55 to 64 years†	1.69*	0.6 to 2.8
	Aged 65 to 74 years†	0.83	-0.2 to 1.8
	Aged 75 years or older†	0.39	-0.6 to 1.4
	Perceives self as overweight	1.16*	0.4 to 1.9
	Perceives self as underweigh	-1.52*	-2.9 to -0.1
Reduced Model	Intercept	-2.19*	-4.3 to -0.1
R^2=0.95	Self-reported weight (kilograms)	1.05*	1.0 to 1.1
R^2(adj)=0.95			
Women			
Full Model	Intercept	-1.25	-3.3 to 0.7
R^2=0.97	Self-reported weight (kilograms)	1.04*	1.0 to 1.1
R^2(adj)= 0.97	Perceives self as overweight	1.25*	0.5 to 2.0
	End-digit preference (0 and 5)	0.52*	0.0 to 1.0
Reduced Model	Intercept	-2.14*	-3.9 to -0.4
R^2= 0.97	Self-reported weight (kilograms)	1.07*	1.0 to 1.1
R^2(adj)=0.97			

† reference group is ages 18 to 24 years
* $p<0.05$
Note: Dependent variable is measured weight.
Source: 2005 Canadian Community Health Survey.

To generate the final equations, adjustments were made for all of the variables in Tables 1 to 3. The final equations are shown in Table 5.

These equations were applied to data in split-sample B to generate corrected estimates of mean height, weight and BMI (Table 6). In all cases, self-reported estimates were statistically different from the measured values, and the corrected estimates were closer than the self-reported estimates to the measured values. In all but one case (the difference in BMI for females in Model 3), the corrected and measured means were not statistically different.

Among men, the proportion who were obese was 13.8% according to self-reported data and 23.1% according to measured data (Table 7); the corrected data generated estimates ranging from 19% to 22%. Self-reported, measured and corrected data yielded similar rates of overweight among men. However, self-reported data overestimated the percentage of men in the normal weight range; the corrected data reduced this bias by 9 to 11 percentage points, with the result that the corrected and measured estimates were similar.

Among women, the proportion who were obese was 12.5% according to self-reported data and 18.9% according to measured data; the corrected data generated estimates ranging from 18.2% to 18.7%. Similarly, for overweight, corrected values were closer than self-reported values to the measured prevalence, with a slight 1-to 2-percentage-point overestimate in the corrected values. Sample sizes in the underweight category were too small to generate reliable estimates.

Sensitivity values in the normal weight category for self-reported data were 93.9% for men and 91.8% for women (Table 8), meaning that in most cases, self-reports correctly classified people of normal weight into the normal weight category.

Sensitivities for the overweight and obese categories fell to 71.1% and 58.7%, for men, and to 62.6% and 68.5% for women. When the data were corrected, sensitivities increased: the corrected numbers accurately classified as many as 86.1% of obese women, 76% of obese men, 79.7% of overweight women, and 82.8% of overweight men. However, the corrected estimates reduced sensitivities for those in the normal weight range.

Specificities were highest for the underweight and obese categories (Table 8), indicating that it is rare for someone to be classified into these groups based on self-reports unless they actually are underweight or obese.

Table 9 displays adjusted odds ratios relating self-reported, measured and corrected BMI to six obesity-related health conditions. An earlier study[16] demonstrated that self-reported BMI exaggerates the relationship between obesity and these health conditions. Unique to the present analysis is that the models have been re-generated based on the corrected estimates. Compared with the odds ratios from the self-reported models, the odds ratios for the corrected models are reduced in most cases (that is, they are closer to the measured values). Arthritis is an exception, with the corrected estimates inflating the relationships for those who are overweight or obese (class II or II - BMI 35 or more kg/m^2) even more than what they would be if based on self-reports. In addition, the odds ratios for obese class I are higher than the self-reported odds ratios for diabetes

Table 3
Regression results for establishing correction equations for height, by sex, Full and Reduced Models generated from split-sample A, household population aged 18 years or older, 2005

	Variable	Coefficient	95% confidence interval
Men			
Full Model	Intercept	12.17*	5.6 to 18.8
R^2=0.82	Self-reported height (centimetres)	0.93*	0.9 to 1.0
R^2(adj)= 0.82	Aged 25 to 34 years†	-1.48*	-2.4 to -0.5
	Aged 35 to 44 years†	-0.43	-1.5 to 0.6
	Aged 45 to 54 years†	-1.23*	-2.3 to -0.1
	Aged 55 to 64 years†	-2.44*	-3.4 to -1.5
	Aged 65 to 74 years†	-2.87*	-4.1 to -1.6
	Aged 75 years or older†	-2.84*	-4.2 to -1.5
	Dissatisfied with life	2.22*	0.3 to 4.1
Reduced Model	Intercept	7.70*	0.7 to 14.7
R^2= 0.81	Self-reported height (centimetres)	0.95*	0.9 to 1.0
R^2(adj)= 0.81			
Women			
Full Model	Intercept	14.85*	9.2 to 20.4
R^2= 0.83	Self-reported height (centimetres)	0.91*	0.9 to 0.9
R^2(adj) = 0.83	Aged 25 to 34 years†	-1.20*	-2.0 to -0.4
	Aged 35 to 44 years†	-0.87*	-1.7 to -0.1
	Aged 45 to 54 years†	-0.59	-1.6 to 0.4
	Aged 55 to 64 years†	-1.34*	-2.6 to -0.1
	Aged 65 to 74 years†	-1.42*	-2.4 to -0.5
	Aged 75 years or older†	-3.79*	-5.0 to -2.5
	East or South East Asian‡	-0.32	-1.8 to 1.2
	Other ethnicity‡	-0.73*	-1.4 to -0.1
	Activity limitation	-0.66*	-1.3 to 0.0
Reduced Model	Intercept	8.05*	2.5 to 13.6
R^2= 0.81	Self-reported height (centimetres)	0.95*	0.9 to 1.0
R^2(adj) = 0.81			

† reference group is ages 18 to 24 years
‡ reference group is White
* p<0.05
Note: Dependent variable is measured height
Source: 2005 Canadian Community Health Survey

Table 4
Regression results for establishing correction equations for body mass index (BMI), by sex, Full and Reduced Models generated from split-sample A, household population aged 18 years or older, 2005

	Variable	Coefficient	95% confidence interval
Men			
Full Model	Intercept	-0.67	-1.8 to 0.5
R^2 = 0.86	Self-reported BMI (kg/m^2)	1.04*	1.0 to 1.1
R^2(adj) = 0.86	Aged 25 to 34 years†	0.64*	0.2 to 1.1
	Aged 35 to 44 years†	0.31	-0.2 to 0.8
	Aged 45 to 54 years†	0.39	-0.2 to 1.0
	Aged 55 to 64 years†	1.28*	0.7 to 1.9
	Aged 65 to 74 years†	1.16*	0.6 to 1.7
	Aged 75 years or older†	0.86*	0.3 to 1.4
	Dissatisfied with life	-0.97*	-1.6 to -0.3
	Perceives self as underweight	-0.73*	-1.3 to -0.1
Reduced Model	Intercept	-1.08	-2.2 to 0.0
R^2 = 0.85	Self-reported BMI (kg/m^2)	1.08*	1.0 to 1.1
R^2(adj) = 0.85			
Women			
Full Model	Intercept	1.01	-0.6 to 2.6
R^2 = 0.92	Self-reported BMI (kg/m^2)	1.01*	0.9 to 1.1
R^2(adj) = 0.92	Highest level of education is secondary graduation‡	-0.91*	-1.5 to -0.3
	Highest level of education is some postsecondary‡	-0.32	-1.3 to 0.7
	Highest level of education is postsecondary graduation‡	-0.53*	-1.0 to 0.0
	Perceives self as overweight	0.70*	0.2 to 1.2
	End-digit preference (0 and 5)	0.29*	0.0 to 0.6
Reduced Model	Intercept	-0.12	-1.5 to 1.3
R^2 = 0.91	Self-reported BMI (kg/m^2)	1.05*	1.0 to 1.1
R^2(adj) = 0.91			

† reference group is ages 18 to 24 years
‡ reference group is less than secondary graduation
* $p<0.05$
Note: Dependent variable is BMI based on measured height and weight.
Source: 2005 Canadian Community Health Survey.

in Models 1 and 2, and for high blood pressure, in Models 3 and 4.

Measured height and weight data were available for only a subsample of the 2005 CCHS. The ultimate goal of developing correction equations is to be able to apply them to the broader survey. When applied to the full sample of the 2005 CCHS (without different adjustments for telephone and in-person interviews) for respondents who were 18 years or older and who were not pregnant or breastfeeding (n=118,383), the models generated obesity estimates similar to, although slightly lower than, the measured values (Table 10). Based on data from both split-sample A and B, the self-reported prevalence of obesity was 16% for both sexes, while the measured prevalence was 25.6% for men and 22.3% for women. The models generated obesity rates of approximately 23% for men and 21% for women.

Limitations

The response rate for the measured height and weight subsample of the CCHS was only 65%. If people who agreed to participate had different height and weight profiles than did those who refused, the sample could be biased. The self-reported prevalence of obesity among everyone who was selected to have their height and weight measured was 15.9% – 19.1% of non-respondents and 14% of respondents. However, when the special sampling weight was applied to those who underwent the physical measures, the prevalence of obesity based on self-reported data fell to 15.2%, comparable to that for the entire subsample.[12]

Bias in self-reported height may be due to inconsistent rounding between self-reported and measured data. When half-inches were reported, interviewers asked respondents to round up to the nearest inch, but for the measured values, height was recorded to the nearest 0.5 cm. Moreover, because interviewers recorded self-reported height only in metres, it was impossible to determine how many people reported in feet and inches and thereby assess the extent of this rounding bias.

For measured weight, it is not known if interviewers consistently asked respondents to empty their pockets and remove their footwear. And for self-reported weight, it is not known if respondents reported their weight with or without clothing, since interviewers told them to report their weight without clothing only if they asked.

Although interviewers were trained in the correct procedures for measuring height and weight, and the weigh scales and measuring tapes were calibrated, intra- and inter- interviewer reliability was not assessed.

BMI is commonly used as a measure of obesity on population surveys, but it has limitations: it cannot distinguish between muscle mass and fat, nor does it consider fat distribution.[26]

Finally, the models generated for this article were limited to the variables collected in the CCHS. It is possible that additional variables that were not part of the survey could be associated with the bias in weight, height or obesity.

Discussion

BMI calculated from self-reported height and weight underestimates obesity prevalence. This has implications for our understanding of the burden of obesity and the relationship between obesity and obesity-related health conditions. This study examined the feasibility of applying correction factors to self-reported estimates to determine if they could be adjusted to more closely approximate measured values.

Table 5
Correction equations to adjust self-reported estimates of weight, height and body mass index (BMI), by sex, Full and Reduced Models, household population aged 18 years or older, 2005

Sex and Model	Equation
Men	
Full Model 1	$Weight_{(measured)}$ = -0.30+1.01($weight_{(self\text{-}reported)}$)+0.54(age 25-34)+0.39(age 35-44)+0.50(age 45-54)+1.69(age 55-64)+0.83(age 65-74) +0.39(75 or older)+1.16(overweight)-1.52(underweight)
	$Height_{(measured)}$ = 12.17+0.93($height_{(self\text{-}reported)}$)-1.48(age 25-34)-0.43(age 35-44)-1.23(age 45-54)-2.44(age 55-64)-2.87(age 65-74)-2.84(75 or older) +2.22(life dissatisfaction)
Full Model 2	$BMI_{(measured)}$ = -0.67+1.04($BMI_{(self\text{-}reported)}$)+0.64(age 25-34)+0.31(age 35-44)+0.39(age 45-54)+1.28(age 55-64)+1.16(age 65-74)+0.86(75 or older) -0.97(life dissatisfaction)-0.73(underweight)
Reduced Model 3	$Weight_{(measured)}$ = -2.19+1.05($weight_{(self\text{-}reported)}$) $Height_{(measured)}$ = 7.70+0.95($height_{(self\text{-}reported)}$)
Reduced Model 4	$BMI_{(measured)}$ = -1.08+1.08($BMI_{(self\text{-}reported)}$)
Women	
Full Model 1	$Weight_{(measured)}$ = -1.25+1.04($weight_{(self\text{-}reported)}$)+1.25(overweight)+0.52(end-digit preference)
	$Height_{(measured)}$ = 14.85+0.91($height_{(self\text{-}reported)}$)-1.20(age 25-34)-0.87(age 35-44)-0.59(age 45-54)-1.34(age 55-64)-1.42(age 65-74)-3.79(75 or older) -0.32(ethnicity E/SE Asian)-0.73(ethnicity other)-0.66(activity limitation)
Full Model 2	$BMI_{(measured)}$ = 1.01+1.01($BMI_{(self\text{-}reported)}$)-0.91(secondary graduation)-0.32(some postsecondary)-0.53(postsecondary graduation)+0.70(overweight) +0.29(end-digit preference)
Reduced Model 3	$Weight_{(measured)}$ = -2.14+1.07($weight_{(self\text{-}reported)}$) $Height_{(measured)}$ = 8.05+0.95($height_{(self\text{-}reported)}$)
Reduced Model 4	$BMI_{(measured)}$ = -0.12+1.05($BMI_{(self\text{-}reported)}$)

Source: 2005 Canadian Community Health Survey

Table 6
Mean weight, height and body mass index (BMI) for measured, self-reported and corrected data generated from split-sample B, by sex, household population aged 18 years or older, 2005

				Corrected			
	Sample size	Self-reported	Measured	Model 1 (Full) Height and weight	Model 2 (Full) BMI	Model 3 (Reduced) Height and weight	Model 4 (Reduced) BMI
Mean height (centimetres)							
Men	942	176.35*	175.21	175.42	...	175.44	...
Women	1,087	162.28*	161.71	161.73	...	161.73	...
Mean weight (kilograms)							
Men	947	81.44*	83.24	83.26	...	83.27	...
Women	1,080	64.47*	66.91	66.76	...	66.75	...
Mean BMI (kg/m²)							
Men	949	26.12*	27.09	27.00	27.05	26.98	27.03
Women	1,080	24.55*	25.73	25.60	25.69	25.58*	25.68

... not applicable
* significantly different from measured estimate ($p < 0.05$)
Source: 2005 Canadian Community Health Survey

In each of the four models tested, and in all analyses undertaken, the corrected estimates provided more accurate measures of overweight and obesity than did the self-reported values. However, this was not the case for the normal weight category. The sensitivity values for the normal weight population fell to as low as 84% in men (a 10-percentage-point decrease) and to 83% in women (a 9-percentage-point decrease). Kuskowska-Wolk et al. also found a reduction in sensitivity for normal weight individuals.[19] We hypothesized that the decline in sensitivity was because heavier individuals have a greater reporting bias[12] (a greater tendency to underestimate their BMI), and therefore, different adjustments may be required depending on where the individual lies on the BMI distribution. Without these differing adjustments, sensitivity declines when a small proportion of

Table 7
Percentage distribution of population, by body mass index (BMI) category and sex, based on self-reported, measured and corrected data from split-sample B, household population aged 18 years or older, 2005

BMI category	Self-reported	Measured	Corrected			
			Model 1 (Full) Height and weight	Model 2 (Full) BMI	Model 3 (Reduced) Height and weight	Model 4 (Reduced) BMI
Men						
Underweight	F	F	F	F	F	F
Normal weight	43.1*	32.2	33.6	32.2	32.8	33.8
Overweight	42.5	44.0	44.1	45.6	48.0	45.7
Obese	13.8*	23.1	21.9	21.6	18.9*	20.1
Women						
Underweight	4.7*E	3.1E	2.7E	1.5*E	2.7E	1.9E
Normal weight	58.2*	46.9	46.8	47.0	46.6	47.1
Overweight	24.6*	31.1	31.8	33.2	32.4	32.7
Obese	12.5*	18.9	18.7	18.3	18.2	18.3

E interpret with caution (coefficient of variation between 16.6% and 33.3%)
F too unreliable to be published (coefficient of variation greater than 33.3%)
* significantly different from measured estimate ($p < 0.05$)
Source: 2005 Canadian Community Health Survey.

Table 8
Sensitivity and specificity values for self-reported and corrected data, by sex, household population aged 18 years or older, 2005

	Underweight		Normal weight		Overweight		Obese		Total	
	%	95% confidence interval	%	95% confidence interval	%	95% confidence interval	%	95% confidence interval	%	95% confidence interval
Sensitivity (% true positives)										
Men										
Self-reported		F	93.9	91.7 to 96.2	71.1	66.2 to 76.0	58.7	51.7 to 65.7	75.0	72.0 to 78.0
Model 1 (Full - height and weight)		F	87.8	83.6 to 91.4	79.8	73.2 to 86.4	76.0	67.1 to 84.9	81.2	77.3 to 85.1
Model 2 (Full - BMI)		F	85.5	80.8 to 90.1	81.1	74.5 to 87.7	74.6	65.5 to 83.8	80.7	76.7 to 84.7
Model 3 (Reduced - height and weight)		F	83.8	77.6 to 90.1	82.8	76.5 to 89.0	70.2	59.9 to 80.4	79.9	75.6 to 84.1
Model 4 (Reduced - BMI)		F	85.8	79.7 to 91.9	81.1	74.7 to 87.6	73.8	64.8 to 82.8	80.7	76.6 to 84.7
Women										
Self-reported	77.8	63.2 to 92.3	91.8	88.9 to 94.8	62.6	56.8 to 68.5	68.5	62.3 to 74.8	77.8	74.9 to 80.7
Model 1 (Full - height and weight)	66.8E	42.6 to 91.2	85.1	79.0 to 91.3	74.3	67.7 to 81.0	86.1	78.7 to 93.5	81.4	77.4 to 85.3
Model 2 (Full - BMI)	39.3E	18.3 to 60.4	83.4	77.2 to 89.6	75.0	68.4 to 81.5	85.1	77.5 to 92.7	79.7	75.7 to 83.8
Model 3 (Reduced - height and weight)	66.8E	43.2 to 90.3	85.6	79.6 to 91.7	77.1	70.7 to 83.6	85.4	78.0 to 92.8	82.4	78.5 to 86.2
Model 4 (Reduced - BMI)	45.6E	24.0 to 67.5	86.9	81.4 to 92.4	79.7	73.9 to 85.5	86.0	78.6 to 93.4	83.2	79.6 to 86.8
Specificity (% true negatives)										
Men										
Self-reported	99.6	99.4 to 99.9	83.2	80.2 to 86.1	79.7	76.3 to 83.2	98.3	96.6 to 99.7	...	...
Model 1 (Full - height and weight)	99.8	99.5 to 100.0	92.2	88.7 to 95.6	84.1	79.8 to 88.3	94.4	91.5 to 97.2	...	...
Model 2 (Full - BMI)	99.7	99.3 to 100.0	93.2	89.8 to 96.6	82.3	77.8 to 86.7	94.3	91.4 to 97.2	...	...
Model 3 (Reduced – height and weight)	99.9	99.7 to 100.0	91.6	88.0 to 95.1	79.3	74.0 to 84.7	96.5	94.3 to 98.7	...	...
Model 4 (Reduced – BMI)	99.8	99.5 to 100.0	91.0	87.3 to 94.7	82.2	77.4 to 87.0	96.1	93.7 to 98.4	...	...
Women										
Self-reported	97.7	96.8 to 98.5	78.3	74.6 to 82.0	88.9	86.5 to 91.2	99.6	99.3 to 99.8	...	...
Model 1 (Full - height and weight)	99.4	98.8 to 99.9	87.1	82.9 to 91.3	87.4	82.9 to 91.9	97.0	95.5 to 98.4	...	...
Model 2 (Full - BMI)	99.7	99.4 to 100.0	85.2	80.8 to 89.7	85.6	81.0 to 90.2	97.3	96.0 to 98.6	...	...
Model 3 (Reduced – height and weight)	99.3	98.8 to 99.9	87.9	84.0 to 91.8	87.7	83.3 to 92.2	97.4	96.1 to 98.7	...	...
Model 4 (Reduced – BMI)	99.6	99.1 to 100.0	88.0	84.1 to 91.9	88.4	84.3 to 92.5	97.5	96.3 to 98.8	...	...

... not applicable
E interpret with caution (coefficient of variation between 16.6% and 33.3%)
F too unreliable to be published (coefficient of variation greater than 33.3%)
Note: Reported estimates are based on data from split-samples A and B. Modelled estimates are generated from split-sample B.
Source: 2005 Canadian Community Health Survey.

Table 9
Adjusted odds ratios relating self-reported, measured and corrected body mass index (BMI) to selected self-reported health conditions, household population aged 40 years or older, 2005

	Based on self-reported values		Based on measured values		Based on corrected values							
					Model 1 (Full)		Model 2 (Full)		Model 3 (Reduced)		Model 4 (Reduced)	
BMI category (range kg/m2)	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Diabetes												
Normal weight (18.5 to 24.9)	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Overweight (25.0 to 29.9)	2.6*	1.5 to 4.3	1.4	0.7 to 2.8	1.8	0.9 to 3.3	2.0*	1.1 to 3.8	1.8*	1.1 to 3.0	2.0*	1.2 to 3.3
Obese class I (30.0 to 34.9)	3.2*	1.8 to 5.6	2.2*	1.0 to 4.5	3.3*	1.8 to 6.0	3.9*	2.1 to 7.0	3.1*	1.7 to 5.7	3.2*	1.8 to 5.8
Obese class II and III (35.0 or more)	9.0*	4.5 to 17.9	5.9*	2.5 to 14.0	6.8*	3.7 to 12.5	7.3*	3.9 to 13.9	7.6*	4.0 to 14.2	7.4*	4.0 to 13.7
High blood pressure												
Normal weight (18.5 to 24.9)	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Overweight (25.0 to 29.9)	2.7*	1.9 to 3.8	2.1*	1.5 to 3.0	2.3*	1.6 to 3.2	2.5*	1.8 to 3.5	2.5*	1.7 to 3.5	2.4*	1.7 to 3.3
Obese class I (30.0 to 34.9)	4.2*	2.9 to 6.3	3.4*	2.3 to 5.2	4.0*	2.8 to 5.9	4.1*	2.8 to 6.0	4.5*	3.0 to 6.6	4.7*	3.2 to 7.0
Obese class II and III (35.0 or more)	6.8*	3.2 to 14.8	5.2*	2.9 to 9.3	6.0*	3.3 to 10.7	6.0*	3.4 to 10.5	6.1*	3.4 to 10.9	5.6*	3.2 to 9.8
Heart disease												
Normal weight (18.5 to 24.9)	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.4	0.9 to 2.3	1.0	0.6 to 1.7	1.3	0.8 to 2.2	1.3	0.8 to 2.2	1.2	0.7 to 2.0	1.4	0.8 to 2.2
Obese class I (30.0 to 34.9)	1.6	1.0 to 2.6	1.5	0.8 to 2.9	1.2	0.7 to 2.0	1.4	0.8 to 2.4	1.3	0.8 to 2.2	1.5	0.9 to 2.5
Obese class II and III (35.0 or more)	3.7*	1.8 to 7.7	2.1	1.0 to 4.4	3.3*	1.8 to 6.2	3.4*	1.8 to 6.5	2.9*	1.5 to 5.6	2.8*	1.5 to 5.5
Arthritis												
Normal weight (18.5 to 24.9)	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.2	0.8 to 1.7	1.2	0.8 to 1.7	1.5*	1.1 to 2.0	1.5*	1.1 to 2.1	1.5*	1.1 to 2.0	1.4*	1.0 to 1.9
Obese class I (30.0 to 34.9)	2.0*	1.3 to 3.0	1.2	0.8 to 1.8	1.7*	1.2 to 2.5	1.9*	1.3 to 2.8	1.9*	1.3 to 2.8	1.7*	1.2 to 2.5
Obese class II and III (35.0 or more)	3.1*	1.5 to 6.3	2.7*	1.6 to 4.6	3.5*	2.0 to 5.8	3.2*	1.8 to 5.4	3.2*	1.9 to 5.6	3.4*	1.9 to 6.0
Activity limitation												
Normal weight (18.5 to 24.9)	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.2	0.9 to 1.6	1.2	0.9 to 1.6	1.2	0.9 to 1.7	1.1	0.8 to 1.5	1.0	0.8 to 1.4	1.1	0.8 to 1.5
Obese class I (30.0 to 34.9)	2.0*	1.3 to 3.0	1.5*	1.1 to 2.2	1.4	0.9 to 2.0	1.4	1.0 to 2.1	1.5*	1.0 to 2.1	1.5*	1.0 to 2.2
Obese class II and III (35.0 or more)	4.3*	2.2 to 8.2	2.9*	1.7 to 4.7	4.2*	2.6 to 6.8	3.7*	2.3 to 6.1	3.9*	2.4 to 6.5	3.1*	1.8 to 5.2
Fair/poor self-perceived health												
Normal weight (18.5 to 24.9)	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.3	0.9 to 2.0	0.8	0.5 to 1.2	1.1	0.7 to 1.6	1.1	0.8 to 1.7	1.0	0.7 to 1.5	1.0	0.7 to 1.5
Obese class I (30.0 to 34.9)	2.8*	1.8 to 4.3	1.7*	1.0 to 2.7	1.6*	1.0 to 2.5	1.7*	1.1 to 2.7	2.1*	1.3 to 3.3	2.1*	1.4 to 3.3
Obese class II and III (35.0 or more)	4.5*	2.0 to 10.2	2.9*	1.6 to 5.2	4.1*	2.4 to 7.0	4.3*	2.4 to 7.8	3.5*	1.9 to 6.5	3.6*	2.0 to 6.6

* significantly different from estimate for normal weight category ($p < 0.05$)
... not applicable
Notes: Models control for age (continuous) and sex. Odds ratios for underweight group not reported because of small sample sizes.
Source: 2005 Canadian Community Health Survey.

normal weight individuals are erroneously shifted to the overweight category. We attempted to address this by incorporating polynomial regressions (quadratic terms for self-reported weight) and spline regression to determine if different slopes could be generated for different weight ranges. The quadratics and differential slopes were not significant, and we were unable to refine the estimates for those in the normal weight range. Therefore, although the adjustments improve the estimates for those who are overweight or obese, the non-adjusted numbers provide better estimates for respondents in the normal weight category because the reporting bias is smaller in this group. Further research is needed to better understand how to improve self-reported overweight and obesity estimates without decreasing sensitivity for those in the normal weight range. More research is also required to determine if differential adjustments are necessary for respondents who were interviewed by telephone.

Despite this drawback, the improvement in classification for overweight and obese individuals is significant, and thus, we recommend the use of corrected estimates in addition to self-reported values in studies examining overweight and obesity in the adult population of the 2005 CCHS. We attempted to adjust for independent variables that were related to the reporting bias, but the R^2 of the Full Models (Models 1 and 2) was either the same as or only slightly higher than that of the Reduced Models (Models 3 and 4, which used only weight, height or BMI). In most cases, including the extra variables offered no predictive advantage. Plankey et al.[31] also found that more complex models (including self-reported BMI and additional covariates) only minimally improved predictive ability. Of the models we tested, all four generated similar means, prevalence rates and sensitivity values;

Table 10
Percentage distribution of population, by body mass index (BMI) category and sex, when corrected estimates were applied to full 2005 Canadian Community Health Survey Sample, household population aged 18 years or older

			Corrected			
BMI category	Self-reported	Measured	Model 1 (Full) Height and weight	Model 2 (Full) BMI	Model 3 (Reduced) Height and weight	Model 4 (Reduced) BMI
Males						
Underweight	0.7[E]	0.9[E]	1.0	1.2	0.9	1.0
Normal weight	41.8	32.4	31.2	30.0	31.2	33.1
Overweight	41.2	41.1	44.3	45.4	44.9	42.9
Obese	16.3	25.6	23.5	23.4	23.0	23.1
Females						
Underweight	4.3	2.6[E]	2.7	2.1	2.5	2.0
Normal weight	54.0	46.1	46.5	46.4	46.8	46.7
Overweight	26.1	29.1	29.9	30.6	30.1	30.6
Obese	15.7	22.3	20.9	21.0	20.7	20.8

[E] coefficient of variation between 16.6% and 33.3% (interpret with caution)
Notes: Measured and reported values were generated based on subsample of respondents whose height and weight were measured.
Source: 2005 Canadian Community Health Survey.

What is already known on this subject?

- Self-reported data underestimate the true prevalence of obesity and overestimate the relationship between obesity and obesity-related health conditions.
- For fiscal and logistical reasons, most population health surveillance in Canada is based on self-reported information.

What does this study add?

- Correction factors can be generated to adjust self-reported data to produce more accurate estimates of obesity.
- Although not perfectly predictive of the measured values of body mass index (BMI), corrected values are an improvement over self-reported estimates.
- For future studies examining BMI for adult populations, based on data from the 2005 Canadian Community Health Survey, corrected estimates of BMI are recommened.

no model stood out as being consistently superior. Model 4, however, had the further advantage of being the most parsimonious, and therefore, showing the greatest utility if it is determined that the equations are generalizable.

This method of generating corrected estimates (linear regression with measured BMI as the outcome) has been used in the past,[10,19,31-34] but to our knowledge, has never been attempted on data for the Canadian population. Plankey et al.[31] concluded that a systematic error was associated with the reporting bias, which was impossible to correct with this method. However, in their work, the self-reported sensitivity values for the obese population (BMI 27.3 kg/m^2 or more) were 80% in men and 85% in women and increased only marginally with the corrected models. By contrast, in the current study, self-reported sensitivity of obesity was much lower—59% for men and 69% for women—and the correction equations increased these values significantly. Also, the reporting bias in our study was two to three times larger than that in the 1976-1980 NHANES II, on which the analysis of Plankey et al.was based.

The generalizability of these equations has not been determined. Some authors[33] assume transportability, while others[30] have shown that correction equations are applicable only to the population for which they have been established. In one Swedish study,[32] researchers demonstrated that because height was under- rather than over-reported in that country, self-reported estimates of BMI did not require calibration.

More research using Canadian data is required to determine if these equations are stable across Canadian populations and over time. It is probable that the increase in obesity in recent years[35] has been accompanied by a corresponding increase in reporting bias, which could indicate temporal instability in the equations. At least one study that has examined the bias over time has found that it has increased.[36]

In the interim, surveys that collect self-reported and measured height and weight would benefit from standardization of protocols to ensure that equipment is regularly calibrated and that respondents are asked to report their weight in a consistent way and are measured in light clothing, without shoes. Rounding should also be minimized, if not eliminated.

Conclusion

Although measured data for height and weight provide the most accurate estimates of the prevalence of obesity

based on BMI, the costs of collecting such data are often prohibitive for large population-based surveys. Corrected estimates, though not identical to measured BMI values, are a significant improvement over estimates based on self-reported data, which substantially underestimate obesity prevalence and overestimate the relationship between obesity and disease.

Acknowledgements

The authors thank Julie Bernier for her methodological assistance and members of the Health Information and Research Division at Statistics Canada for their input on this research.

References

1. World Health Organization. *Obesity and Overweight*. Geneva: World Health Organization; 2006 [cited 2008 May 7]. Available from: http://www.who.int/mediacentre/factsheets/fs311/en/index.html.
2. Tjepkema M. Adult obesity. *Health Reports* (Statistics Canada, Catalogue 82-003) 2006; 17(3): 9-25.
3. Shields M. Overweight and obesity among children and youth. *Health Reports* (Statistics Canada, Catalogue 82-003) 2006; 17(3): 27-42.
4. Rigby N, Leach R., James WPT. Seeking bold solutions for Britain's runaway obesity epidemic. *International Obesity Taskforce Briefing Paper*. London: IOTF, 2003.
5. Sturm R, Ringel JS, Andreyeva T. Increasing obesity rates and disability trends. *Health Affairs* 2004; 23(2): 199-205.
6. Katzmarzyk PT, Janssen I. The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology* 2004; 29: 90–115.
7. Engstrom JL, Paterson SA, Doherty A, et al. Accuracy of self-reported height and weight in women: an integrative review of the literature. *Journal of Midwifery and Women's Health* 2003; 48: 338–45.
8. Niedhammer I, Bugel I, Bonenfant S, et al. Validity of self-reported weight and height in the French GAZEL cohort. *International Journal of Obesity and Related Metabolic Disorders* 2000; 24: 1111–18.
9. Nieto-Garcia FJ, Bush TL, Keyl PM. Body mass definitions of obesity: sensitivity and specificity using self-reported weight and height. *Epidemiology* 1990; 1: 146–52.
10. Rowland ML. Self-reported weight and height. *The American Journal of Clinical Nutrition* 1990; 52: 1125–33.
11. Connor Gorber S, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obesity Reviews* 2007; 8: 307-26.
12. Shields M, Connor Gorber S, Tremblay M. Estimates of obesity based on self-report versus direct measures. *Health Reports* (Statistics Canada, Catalogue 82-003) 2008; 19(2): 61-76.
13. Puhl RM, Brownell KD. Psychosocial origins of obesity stigma: toward changing a powerful and pervasive bias. *Obesity Reviews* 2003; 4: 213-27.
14. Kumanyika S, Jeffery RW, Morabia A, et al. Obesity prevention: the case for action. *International Journal of Obesity* 2002; 26: 425-36.
15. Canadian Institute for Health Information. *Improving the Health of Canadians: Promoting Healthy Weights*. Ottawa: Canadian Institute for Health Information, 2006.
16. Shields M, Connor Gorber S, Tremblay M. Effects of measurement on obesity and morbidity. *Health Reports* (Statistics Canada, Catalogue 82-003) 2008; 19(2): 77-84.
17. Yannakoulia M, Panagiotakos DB, Pitsavos C, Stefanadis C. Correlates of BMI misreporting among apparently healthy individuals: the ATTICA study. *Obesity* 2006; 14(5): 894-901.
18. Chiolero A, Peytremann-Bridevaux I, Paccaud F. Associations between obesity and health conditions may be overestimated if self-reported body mass index is used. *Obesity Reviews* 2007; 8: 373-4.
19. Kuskowska-Wolk A, Bergstrom R, Bostrom G. Relationship between questionnaire data and medical records of height, weight and body mass index. *International Journal of Obesity* 1992; 16: 1-9.
20. Statistics Canada. Population health surveys. Ottawa: Statistics Canada; 2005 [cited 2008 Jan 20]. Available from: http://www.statcan.ca/english/concepts/hs/index.htm#content.
21. Béland Y. Canadian Community Health Survey – methodological overview. *Health Reports* (Statistics Canada, Catalogue 82-003) 2002; 13(3): 9-14.
22. Ziebland S, Thorogood M, Fuller A, Muir J. Desire for the body normal: body image and discrepancies between self-reported and measured height and weight in a British population. *Journal of Epidemiology and Community Health* 1996; 50: 105–6.
23. Bostrom G, Diderichsen F. Socioeconomic differentials in misclassification of height, weight and body mass index based on questionnaire data. *International Journal of Epidemiology* 1997; 26: 860-6.

24. Roberts RJ. Can self-reported data accurately describe the prevalence of overweight? *Public Health* 1995;109: 275-84.

25. World Health Organization. *Physical Status: The Use of and Interpretation of Anthropometry, Report of the WHO Expert Committee* (WHO Technical Report Series, No. 854) Geneva: World Health Organization, 1995.

26. Health Canada. *Canadian Guidelines for Body Weight Classification in Adults* (Catalogue H49-179) Ottawa: Health Canada, 2003.

27. Rao JNK, Wu CFJ, Yue K. Some recent work on resampling methods for complex surveys. *Survey Methodology* (Statistics Canada, Catalogue 12-001) 1992; 18(2): 209-17.

28. Rust KF, Rao JNK. Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research* 1996; 5: 281-310.

29. Statistics Canada. *Canadian Community Health Survey Cycle 3.1 Derived Variable Specifications*. Ottawa: Statistics Canada, 2006.

30. Visscher TLS, Viet AL, Kroesbergen HT, Seidell JC. Underreporting of BMI in adults and its effect on obesity prevalence estimations in the period 1998 to 2001. *Obesity* 2006; 14(11): 2054-63.

31. Plankey MW, Stevens J, Flegal KM, Rust PF. Prediction equations do not eliminate systematic error in self-reported body mass index. *Obesity Research* 1997; 5(4): 308-14.

32. Bolton-Smith C, Woodward M, Tunstall-Pedoe H, Morrison C. Accuracy of the estimated prevalence of obesity from self reported height and weight in an adult Scottish population. *Journal of Epidemiology and Community Health* 2000; 54:143-8.

33. Cawley J. The impact of obesity on wages. *The Journal of Human Resources* 2004; 39(2): 451-74.

34. Nyholm M, Gullberg B, Merlo J, et al. The validity of obesity based on self-reported weight and height: implications for population studies. *Obesity* 2007; 15(1): 197-208.

35. Katzmarzyk PT. The Canadian obesity epidemic, 1985–1998. *Canadian Medical Association Journal* 2002; 166: 1039–40.

36. Ezzati M, Martin H, Skjold S, et al. Trends in national and state-level obesity in the USA after correction for self-report bias: analysis of health surveys. *Journal of the Royal Society of Medicine* 2006; 99: 250-7.